July 2010

Science Reporter

A CSIR Publication

Kiwifruit: Miracle Berry Pg 52

Controlling Malaria Pg 40

Measuring *Rainfall*

Plus

- *Connect to Decode*
- *India's Aging Nukes*
- *Hidden Hunger*
- *Fiction and Humour*

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Science Reporter

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National Institute of Science Communication And Information Resources (NISCAIR)
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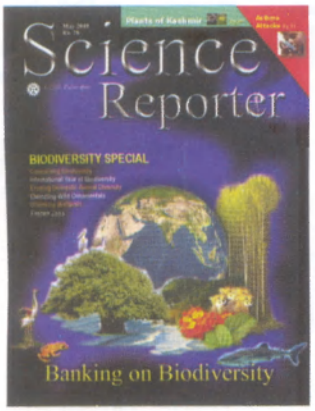
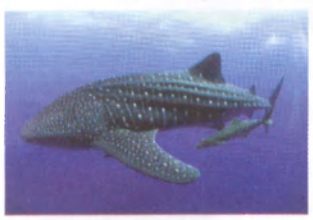


Whale a While

The Fish Facts article in Fun Quiz was interesting, informative and with strikingly glossy pictures (February 2010). The blue whale, it may be mentioned, belongs to the mammalian order setacea, suborder mysticeti (baleen or great whales). Growing upto 100 feet they can be almost the size of the largest dinosaur that



roamed the earth. They can communicate with each other over the entire ocean, because they produce extremely low frequency sound of 10-12 hertz, which suffers from low propagation loss. They are perhaps able to make use of the SOFAR (Sound Fixing and Ranging) duct that facilitates long distance transmission.

The sperm whale is the largest oduntoceti (toothed whale) and possesses the largest brain ever to evolve on the earth. These whales while hunting for squids can dive up to 800 metres. It may be noted that whales do not suffer from decompression sickness (to which humans are susceptible). This is due to the fact that before diving they saturate their tissues with oxygen and draw on their reserves. Since no gas is inhaled no gas can dissolve in the blood. Its substantial bulk is supported by the buoyancy of water. Male humpbacks are accomplished singers and can sing 20 hours a day often mimicking the songs of others.

Shashi
Indore

Label Food Colours

The article Biocolours: Safe Food Colours by S. Srivastava and Bangali Baboo (April 2010) was highly informative and interesting. The table of possible health hazards is worth preserving. The authors have very rightly pointed out that biocolours are more sustainable sources of colourants than their synthetic counterparts.

Biocolours are natural, harmless dyes derived from plants, insects and mineral products without any artificial addition and without harmful effects on health. Synthetic colours are good substitutes giving a better look, good flavor, more cost effective, and therefore, are more acceptable. But synthetic colours are usually mixed with many harmful chemicals that can cause serious health problems. Synthetic colour adds nothing to nutritional value. Numerous colours have even been banned as they were found to be carcinogenic. Even some certified food colors in use today are of a class of chemicals called polycyclic aromatic hydrocarbons that are universally suspect as carcinogenic.

Behavioural studies have indicated that there is a possibility that, for sensitive individuals, some colours might elevate hyperactive tendencies. Synthetic food colours, particularly tartrazine, have occasionally been implicated in cases of adverse reactions to food. Food colour induced asthma or other allergy-like reactions have been documented, especially in case of individuals who are sensitive

to a wide range of environmental and dietary components. Asthma, urticaria/ hives, and hyperactivity have also been associated with synthetic food colours for some people.

Labelling of food additives, including colours, along with the other ingredients can enable people to identify colours that have been added to a food.

Dr.S.K. Aggarwal
Dean Academics
Amritsar College of Engineering and Technology

More on Pi

A mnemonic for pi by the famous British astronomer Sir James Jeans has been quoted in the article Unending Journey of Pi by Ramdas Iyer and Bharat Bhushan Shrivastava (April 2010), which reminds me of the following verse, which we had picked up in our college days, giving its value correct to 20 decimal places:

Sir, I have a rhyme excelling.
In mystic force and magic spelling.
Celestial spirits elucidate
All my own striving can't relate.

As has been mentioned, pi has been calculated up to 2.7 trillion digits. This demonstrates the awesome power of the modern number-crunching computers. It may be pertinent to note that for most practical purposes pi can be considered as 3.14. Also it may be mentioned that just 40 decimal places would give the circumference of the entire visible universe with an error imperceptible even with an electron microscope.

Dr. S.K. Gurtu
Mansarovar, Jaipur

Something to Show-off

Science Reporter is really doing a good job of providing great scientific knowledge. It's a complete source of knowledge. Often my friends ask me how I've so much information? And I tell them that I have the ultimate source of knowledge – *Science Reporter*. It has provided a great platform to me in my class. For instance, the article on Sherlock Holmes in the March issue was really thrilling. I am now going to be the centre of attraction in the class this time also when I tell them about the science behind Sherlock Holmes's deductions.

Rajat Kumar Mahaych
Mahendargarh (Haryana)

Corrigendum

In the May 2010 issue, in the article, Nature's Medicinal Treasure: The Kashmir Valley, there was a mix-up in the labeling of plants on pages 30 and 31. Please read *Crocus sativus* instead of *Atropa belladonna*; *Achillea millefolium* instead of *Inula racemosa*; *Atropa belladonna* instead of *Crocus sativus* and *Inula racemosa* instead of *Achillea millefolium*.

Also *Artemisia maritime* may be read as *Artemisia maritima*.

The errors are regretted.

HAVE YOUR SAY

If you feel strongly about any article or write-up published in *Science Reporter* or have some information to share with the readers, please write to us at the postal address given in the magazine or send an Email at sr@niscair.res.in.

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The Green Indian Consumer

Green is 'in' these days. You have green industries, green appliances, green buildings, green computing, green fuels, and so on. In fact, "green marketing", or the marketing of products that are presumed to be environmentally safe, is fast emerging as a marketing punch line meant to appeal to consumers' consciousness. There is a growing market among consumers worldwide for sustainable and socially responsible products and services today. It is, therefore, indeed remarkable that a global survey has found Indian consumers to be the greenest.

The report, Greendex 2010: Consumer Choice and the Environment, by the National Geographic Society and the international polling firm GlobeScan has ranked Indian consumers as the "greenest" in the world in its latest survey. However, American consumers' behaviour still ranks as the least sustainable of all countries surveyed, followed by Canadian, French and British consumers. Covering 17,000 consumers across 17 nations, the quantitative consumer study asked about such behaviour as energy use and conservation, transportation choices, food sources, the relative use of green products versus traditional products, attitudes towards the environment and sustainability, and knowledge of environmental issues.

Overall, the study found that environmentally friendly behaviour among consumers in 10 out of 17 countries has increased over the past year. For instance, the study found that majority of consumers in 15 of the 17 countries surveyed indicated that they prefer to repair something when it is broken rather than to replace it. Since 2008, there has also been a significant increase in the number of Americans, Chinese, and Indians who generally try to buy things "used" or "pre-owned" rather than new. All this points to an emerging environmental conscience worldwide and is a welcome sign indeed.

In the Indian context, the study found that the percentage of consumers who said that the environment is the single most important issue facing their country has increased notably. Indian consumers were also most likely to cite environmental concerns for the decisions they take. For instance, in the transportation sector, consumers in India are the most likely to say that they live close to their usual destinations, or perhaps move closer to their workplace, to minimize the impact of their personal transportation on the environment.

Indian consumers were also most likely to say that they have reduced their frequency of driving alone in a car. One would assume that in some cases it could be due to fuel costs but in most cases conscious decision has also been taken to pool cars to reduce the carbon footprint. Likewise, Indian consumers, along with the Chinese, are the most frequent users of public transportation and the most likely to report that they use it to save fuel and reduce pollution at least in part.

The study also found that consumers who were most likely to avoid environmentally unfriendly products or buy environmentally friendly products were most common in emerging economies, particularly China and India. Living habits also give Indian consumers a green edge. For instance, they were most likely to shop for groceries and vegetables from local markets rather than depend on imported goods. Also, only 38% of Indians are likely to have hot running water in their homes, and most people use energy-saving "on-demand" water heaters.

One hopes, however, that the trend does not change for the worse. Let us avoid the same mindless development path as the west that has caused the earth to warm up, the glaciers to recede, the forests to vanish, the rivers to dry up, and the air to be rendered unbreathable. Let the green Indian consumer be an example for the world.

Hasan Jawaid Khan

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K.V. BALASUBRAMANIAN

How Much Did It Rain?

Rain Rain Rain

Measuring rainfall forms a very important input for the economic planning of the country. But there is a whole lot of scientific work and periodic maintenance that goes into making this activity a reality.

WHEN the first showers of the monsoon give respite from the sweltering heat, the first thing you do is smell the earthy flavour wafting through to your nose. You might also want to catch a few drops on your palm or perhaps get drenched in the pouring rain. But why would someone want to measure the rainfall? Is it important?

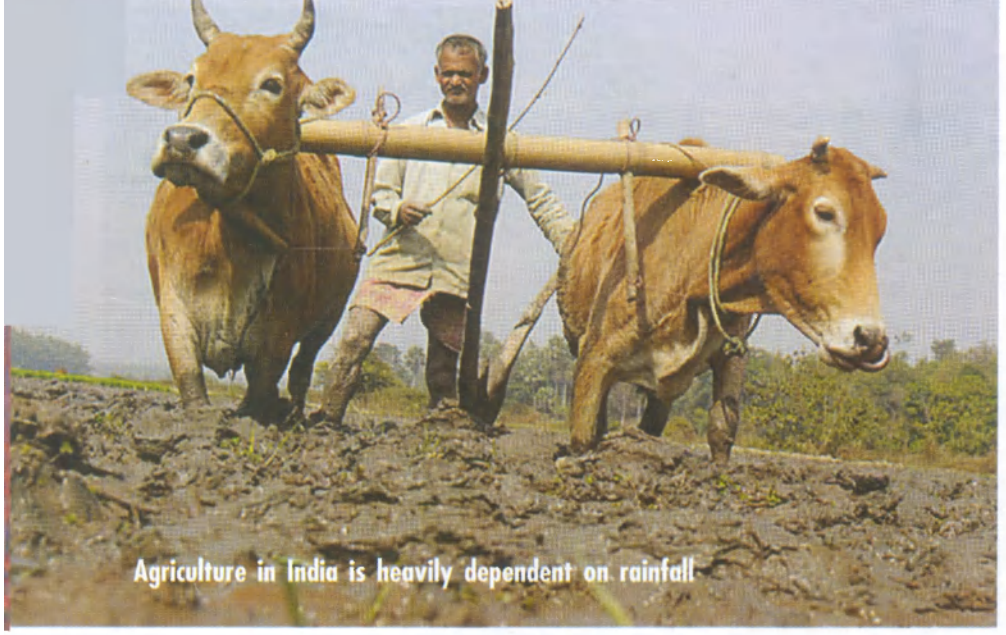
Well, the oceans hold 97% of the earth's water (which is saline), while 2% is available frozen in ice caps. Deep ground water accounts for 0.31%. The remaining 0.69% of water is only available for the humanity. The main source of this small amount of water is precipitation in the form of rain or snow. So, measurement of this precipitation (rainfall/snowfall) becomes absolutely necessary since it forms a very important input for the economic planning of a country.

In a country like India virtually the entire economy tends to depend on the arrival of the monsoon and small farmers rely on rains to irrigate their fields. It becomes necessary, therefore, to be able to calculate the amount of rain received in a particular season or year and relate it to economic parameters. Subsequently projections of expected rainfall and the consequent impact on the economy are worked out.

History of Rainfall Measurement

The modern history of rainfall recording and measurement is related to the history of the Meteorological Department in India. The meteorological observations, including rainfall, were recorded from 1793 onwards at the Madras Observatory (at Nungambakkam, Chennai). Similar observations were taken at Simla from 1840, at Colaba (Mumbai) from 1841, at Doddapetta (Nilgiris) from 1847 and at Kolkatta from 1853.

In the middle of the 19th century, governments at the state level established rain gauges under the state revenue departments. The damages caused by severe cyclone that crossed near Machilipatnam coast during October 1864 were instrumental in the efforts of the British to establish an



Agriculture in India is heavily dependent on rainfall

organized rainfall registration network. The number of meteorological observatories was increased during 1860 to 1870 by the Provincial governments.

In 1875, the India Meteorological Department (IMD) was established. Symons's 5-inch rain gauge with rain measurer was in general use at that time in Bengal, Assam, and Madras. After 1875, as per new guidelines, rain gauges were directed to be installed with their mouth one foot above the ground. Hours of observations were fixed at 10 a.m., 1 p.m. and 4 p.m. for rainfall registration and 6 p.m. for recording Maximum Temperature.

In 1888, the system of rainfall registration in the different provinces and states of India was unified under the technical direction of the Director General of Observatories. The time of rainfall observations was fixed at 8 a.m. Local Time (LT) to make it conform to the time at which observations were being recorded at meteorological observatories in India in the morning. This time was later changed from 8 a.m. LT to 0800 hours IST from 1 January 1943 to meet the requirements of aviation for which strictly simultaneous or synoptic observations are required than those taken according to LT, which vary from place to place.

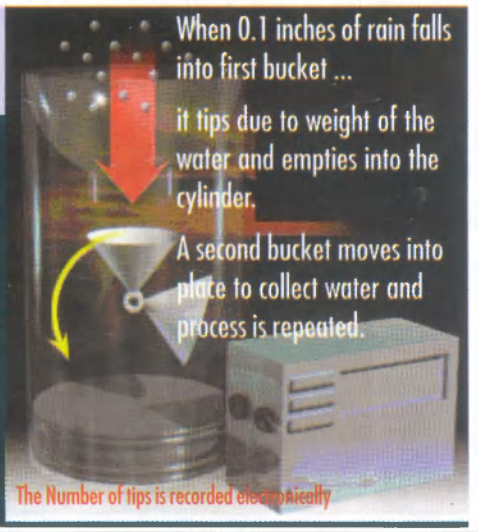
From 1 March 1949, this time was further changed to 0830 hours IST to make it conform to the world standard viz., 0300 hours UTC/GMT that was fixed by IMO (International Meteorological Organisation) as one of the eight standard times of synoptic observations throughout the world.

The India Meteorological Department was responsible only for the observatories under its control. For a large country like India, whose economy depends upon the monsoon rainfall, it was necessary to have a standard rain gauge network for rainfall measurement. So, the various State Governments were asked to:

1. Install, maintain and inspect all rain gauge stations in the respective states,
2. Record and collect rainfall data from these stations,
3. Regularly publish the rainfall data in state gazettes and
4. Supply printed statements of daily and monthly rainfall of various rain gauges in their jurisdiction in the prescribed forms to IMD.

The IMD further provides technical advice to State Governments on all matters connected with rainfall registration, such as selection of sites and installation of rain gauges, methods of rainfall observation, inspection of rain gauge stations, compiles and issues consolidated reports on rainfall data for the whole of India for each calendar year, and is also responsible for various studies pertaining to rainfall.

Christopher Wren who invented the tipping bucket rain gauge; a view of the tipping bucket rain gauge (right)


When 0.1 inches of rain falls into first bucket ...
it tips due to weight of the water and empties into the cylinder.
A second bucket moves into place to collect water and process is repeated.
The Number of tips is recorded electronically

Measurement of Precipitation

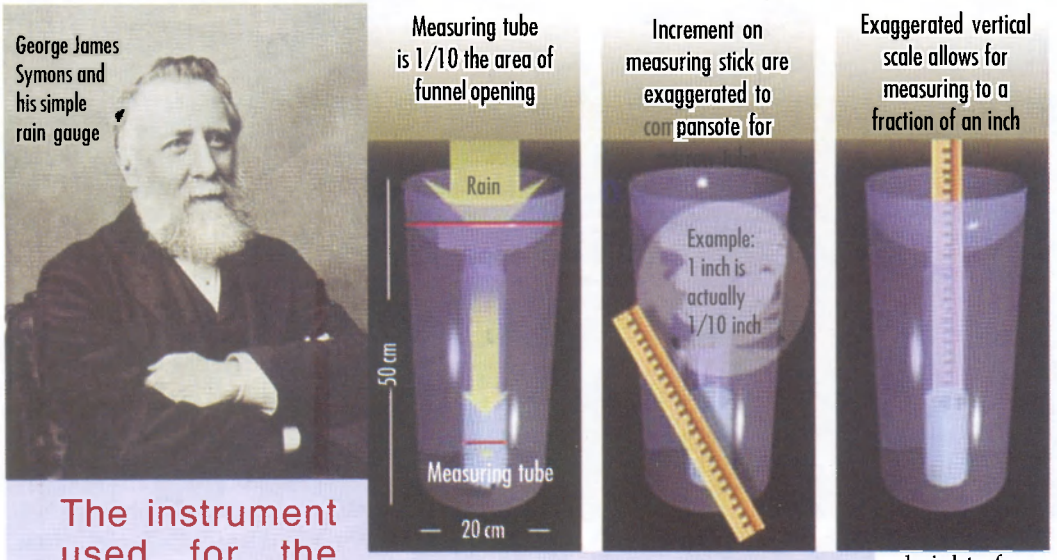
Precipitation could be either in liquid form (rainfall including drizzle, rain and shower) or solid form (snowfall), or mixed form (sleet). Whether it is in the form of rain or snow, precipitation is measured and expressed in terms of depth or thickness of layer it would form on the horizontal surface of the earth if there were no loss by evaporation, runoff or by infiltration.

The instrument used for the measurement of rainfall is called a rain gauge. Snow gauge is used for measuring snow. Rain gauge is also known by various names such as 'Hyetometer', 'Ombrometer', and 'Pluviometer'.

The intensity of precipitation is the rate at which the precipitation would accumulate on a horizontal surface, if there is no run off. Intensity of precipitation could be light, moderate or heavy:

- Light : not more than 0.5 mm per hour
- Moderate : between 0.5 mm to 4.0 mm per hour
- Heavy: more than 4.0 mm per hour

The above classification is for rainfall. A slightly different classification is used for other forms of precipitations like drizzle and shower (Table 1).


George James Symons and his simple rain gauge
Measuring tube is 1/10 the area of funnel opening
Rain
50 cm
Measuring tube
20 cm
Increment on measuring stick are exaggerated to compansote for
Example: 1 inch is actually 1/10 inch
Exaggerated vertical scale allows for measuring to a fraction of an inch

The instrument used for the measurement of rainfall is called a rain gauge

Also, based on accumulated rainfall for 24 hours, if the amount is more than 6.5 cm and up to 12.5 cm it is classified as heavy rainfall. If the amount of rainfall is more than 12.5 cm then it is classified as very heavy rainfall (see Table 2).

Rain Gauge Network

A rain gauge is an instrument used by meteorologists and hydrologists to collect and measure the amount of liquid precipitation. There are about 8,000 rain gauges in India at present. These are available in the Surface Observatories of the IMD (557), Hydro-meteorological Observatories of IMD (622), Non-IMD rain gauge stations under various schemes (but data received by IMD) (4946), Agro-meteorological Observatories (424), Pilot Balloon observatories of IMD and other types of Observatories of IMD (48) (numbers as on 01.01.1994). Apart from the above, some more rain gauges are maintained by other agencies for their specific projects.

The different types of rain gauges can be broadly classified into Non-recording rain gauges and Recording rain gauges.

Non-recording rain gauges

1. *Symons's 5" simple rain gauge:* It is made of galvanized iron sheet of 12-gauge thickness. It consists of a) Base, b) Body, c) Receiver, d) Funnel and e) Measure Glass.

The outer diameter of the funnel is 5 inches or 12.7 cm. The outer peripheral ring is made of gunmetal (a kind of bronze formerly used for making cannons) and is called rim.

The rainwater received by the funnel is transmitted into a collecting jar or collector or plastic bottle placed inside an outer jacket or receiver. The outer jacket is a cylindrical vessel closed at one end and collects overflow of rainwater. The funnel, collector, and receiver are fitted into a base that has a locking arrangement. The rain gauge is installed in leveled cement platform so that the gunmetal rim is at a height of one foot above the ground to avoid splashing of water.

The rainfall collected in the collector is measured daily at 0830 hours IST with a measure glass. The size of the measuring cylinder is in proportion of the area of the funnel exposed. The cross sectional area of the measuring glass is taken as 1/10th cross sectional area of the receiving funnel. Therefore, 10 times magnification is obtained. One full measure glass contains 1.25 cm of rain or 0.5-inch rain. The measure glass has 50 divisions. It can measure as low as 0.01 inch or 0.025 cm or 0.25 mm of rainfall.

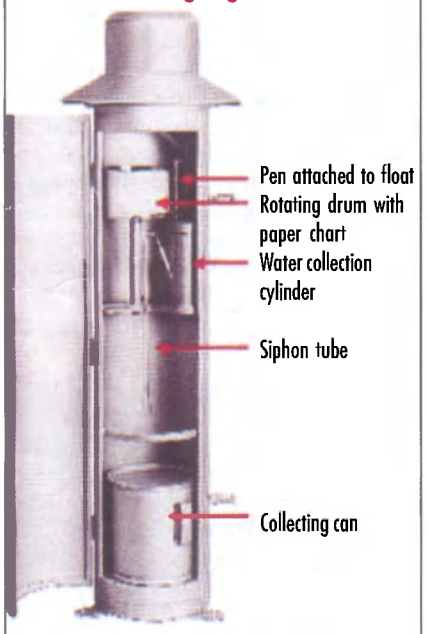
2. *FRP rain gauge:* Symons's rain gauge was the standard rain gauge of India Meteorological Department. Since

Some modern rain gauges

A Digital Rainfall Recorder consisting of a weatherproof enclosure with a data logger and power supply, solar panel, tripod stand and a tipping bucket type rain gauge sensor.

A professional rain gauge (above); and Standard rain gauge (right)

Mechanical drum recording rain gauge



1969, on the recommendation of the World Meteorological Organization, FRP (Fiber Glass Reinforced Polyester) rain gauges are being used. Its essential parts are:

(a) Collector of circular shape with gunmetal rim having area 100 or 200 sq cm. The collectors are interchangeable. The collector has the deepest funnel and the complete rain gauge is tapered slightly with narrower portion at the top.

(b) Base: There are two types of interchangeable bases.

(c) Bottle made of polythene where rain falling into the funnel gets collected.

(d) Measure glass: The rain collected in the bottle is measured with the appropriate specific measure glass. The measure glass is graduated in tenths of millimeter. The capacity of the measure glass is 20 mm of rain.

The rain gauge is installed in 60x60x60 cm masonry or concrete and base is embedded so that the rim of the gauge is 30 cm above the ground. It is installed at a site that is easily accessible during the wet season, well leveled, and free from obstruction such as trees, buildings, shrubs etc.

Doppler-on-Wheels (DOW) radar of the University of Oklahoma for measuring rainfall (left)

Measuring Rainfall With Mobile Phone Antennas

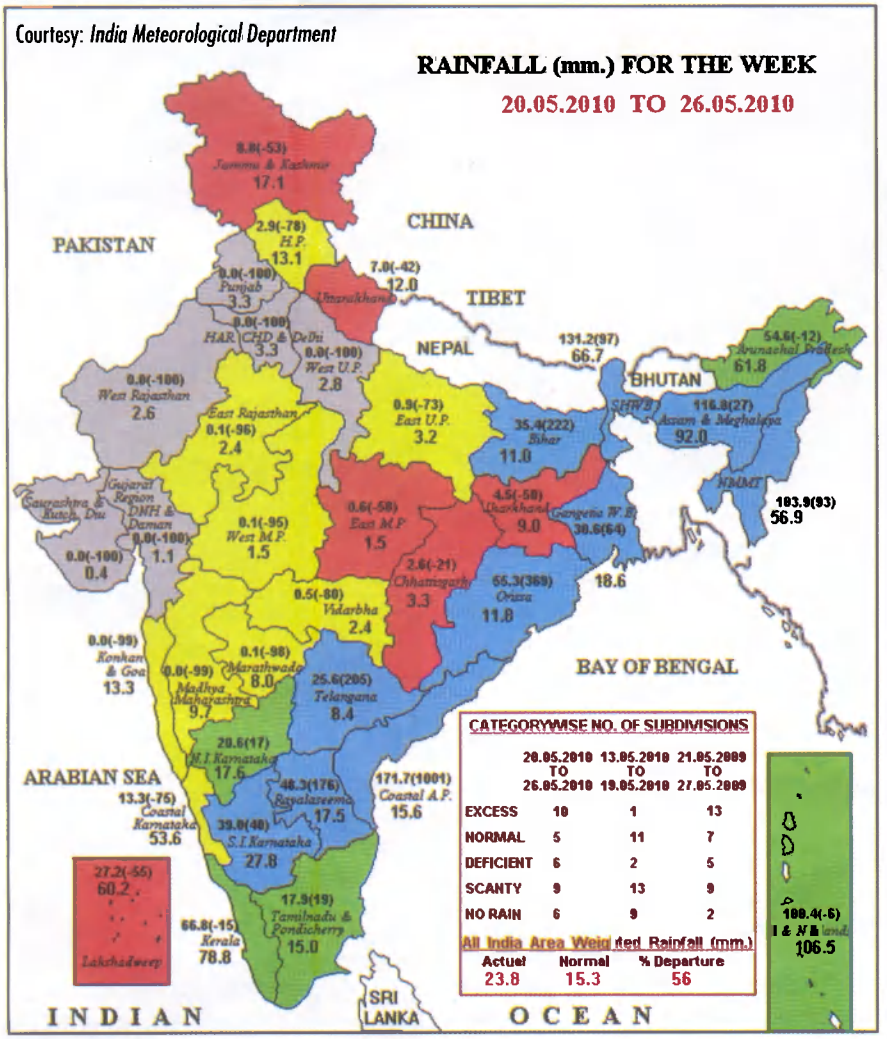
Meteorological radars can also used to detect the intensity and amount of rainfall continuously in space and time. The radar transmits electro-magnetic energy pulses that travel with the speed of light in a direction shown by the movable radar antenna. A part of the beam is reflected back by rain bearing cloud particles.

And, more recently, since rain interferes with radio signals, researchers have been able to measure rainfall using data supplied by the mobile phone antennas. The new method offers greater spatial resolution than traditional point measurements provided by rain gauges. In the future, this could be combined with intelligent control systems for sewer networks so as to reduce water pollution in urban areas.

How does the method work? It takes advantage of what is essentially a nuisance for mobile network operators – the fact that raindrops interfere with microwave radio links between base stations, thereby disrupting signal transmission. Data on the attenuation of signal strength is used to calculate the intensity of rainfall along the path between two antennas. Thanks to the density of the mobile phone network, the resolution of the rainfall data is superior to that provided by rain gauges or weather radar.

In contrast to point measurements, the mobile signal data is based on a network of overlapping microwave radio links. However intense a small-scale storm may be, it will not be captured by a rain gauge located even 100 metres away. While weather radar can cover a wide area, it has the disadvantage that radar signals are heavily attenuated by intense rainfall. In addition, misleading echoes are generated by the terrain, especially in mountainous areas.

Courtesy: *India Meteorological Department*



NOTES:
(a) Rainfall figures are based on operational data.
(b) Small figures indicate actual rainfall (mm.), while bold figures indicate Normal rainfall (mm.)
Percentage Departures of Rainfall are shown in Brackets.

Next time you come across statements in television, radio, or newspapers such as: *'Chennai recorded 3 cm of rainfall', 'The normal rainfall of this year will be around 100 cm'*, remember, a lot of scientific work has gone in before the small amount of rainfall could be worked out.

The India Meteorological Department in New Delhi

The time of observation generally in all rain gauge stations is 0830 hours IST. However, in the observatories maintained by India Meteorological Department it is measured at every three hours, corresponding to the standard hours of observations. These observations (in which all weather parameters such as temperature, pressure etc are taken) are taken at 0230, 0530, 0830, 1130, 1430, 1730, 2030, and 2330 hours of IST, depending upon the type of observatory. The rainfall is measured in 'mm' and tenths of mm. If the rainfall is less than 0.1 mm then the amount of rainfall is entered as 'trace'.

Now how is the measurement done? The funnel is removed and the polythene bottle is taken out. The rainwater collected inside the bottle is poured into the measuring glass and the bottom meniscus is read. If rainwater is more than 20 mm, then it is measured in suitable installments. One division of measure glass is equivalent to 0.2 mm of rain.

Recording rain gauges

Simple rain gauges measure only total quantity of rainfall during the last 24 hours and other details of rainfall characteristics are not available. Self-recording rain gauge gives record of following precipitation characteristics:

1. Total quantum of rainfall in 24 hours
2. Intensity of rainfall
3. Durations of dry and wet periods

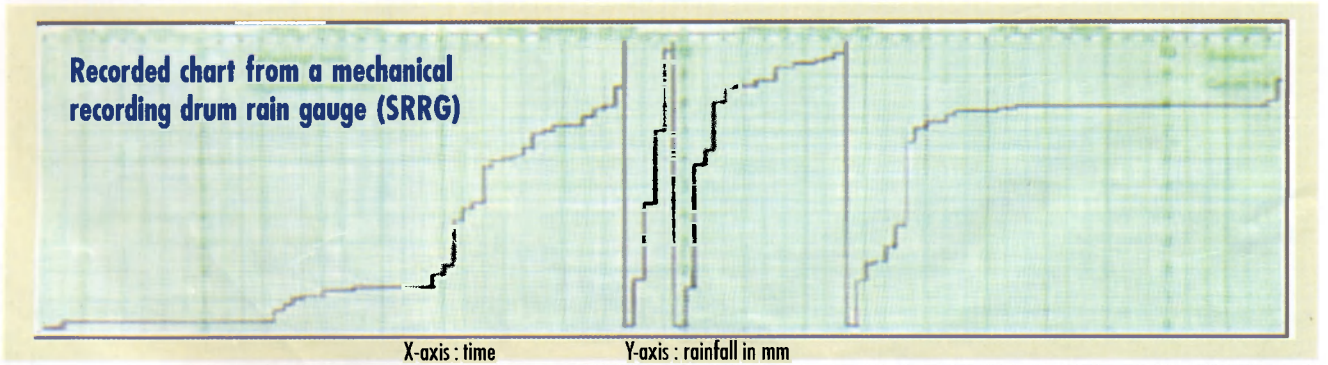


Table 1: Rate of rainfall

Intensity	Rate of rainfall
Rain	
a) Slight	Not more than 0.5 mm/hour
b) Moderate	Between about 0.5 and 4 mm/hour
c) Heavy	More than 4 mm/hour
Showers	
a) Slight	Not more than 2 mm/hour
b) Moderate	Between about 2 and 10 mm/hour
c) Heavy	Between 10 and 50 mm/hour
d) Violent	More than 50 mm/hour
Drizzle	
a) Slight	Trace
b) Moderate	Trace
c) Heavy	Upto 1 mm/hour

Rainfall character is decided by the total amount of rain that has fallen in a set period.

Table 2: Rainfall Intensity based on 24 hours accumulated rainfall
(Followed by India Meteorological Department from 31 May 2006)

24 hours accumulated rainfall in mm	Intensity description
0	No Rain
0.1 to 2.4	Very Light
2.5 to 7.5	Light
7.6 to 35.5	Moderate
35.6 to 64.4	Rather Heavy
64.5 to 124.4	Heavy
124.5 to 244.4	Very Heavy
More than 244.4	Extremely Heavy
When the amount is a value near about the highest recorded rainfall at or near the station for the month or the season. However, this term will be used only when the actual rainfall amount exceeds 12 cm	Exceptionally Heavy

4. Exact beginning, cessation and duration of rainfall

The following types of recording rain gauges are popular:

1. *Weighing rain gauge*: In this, the weight of the water or snow during precipitation moves a platform downward. The platform is arranged on a spring balance. The downward movement of the platform is fed to a pen-and-ink arrangement by lever. The pen makes marking on the graph paper graduated on one axis in inches or centimeters of rain and time on the other axis. The graph paper is fitted on the clock driven drum. The Ferguson rain gauge is a example of this type. This rain gauge can also be used to measure snowfall.

2. *Tipping bucket rain gauge:* The tipping bucket rain gauge consists of a large copper cylinder set into the ground. At the top of the cylinder is a funnel that collects and channels the precipitation. The precipitation falls onto one of two small buckets or levers, which is balanced in the same manner as a scale (or child's seesaw). After an amount of precipitation equal to 0.2 mm (0.007 in) falls, the lever tips and an electrical signal is sent to the recorder. The recorder consists of a pen mounted on an arm attached to a geared wheel that moves once with each signal sent from the collector. When the wheel turns the pen arm moves either up or down leaving a trace on the graph and at the same time making a loud click. Each jump of the arm is sometimes referred to as a 'click' in reference to the noise. The chart is measured in 10-minute periods (vertical lines) and 0.4 mm (0.015 in) (horizontal lines), rotates once every 24 hours, and is powered by a clockwork motor that must be manually wound.

The tipping bucket rain gauge is not as accurate as the standard rain gauge because the rainfall may stop before the lever has tipped. When the next period of rain begins, it may take no more than one or two drops to tip the lever. This would then indicate that 0.2 mm (0.007 in) has fallen when in fact only a minute amount has. The advantage of the tipping bucket rain gauge is that the character of the rain (light, medium or heavy) may be easily obtained.

Rainfall character is decided by the total amount of rain that has fallen in a set period (usually 1 hour) and by

Make Your Rain Gauge

Things you will need
Wide-mouth glass jar
Permanent marker or glass paint
Ruler, tape measure or yard stick
Metal clothes hanger
Pliers
Wire snips

1. Place the jar on a flat, level surface. Place a measuring device, such as a ruler, into the bottom of the jar. This will account for the thickness of the jar bottom.
2. Mark the outside of the jar at the desired intervals, such as 1/4 or 1/2 inch, using a waterproof permanent marker or glass paint.
3. Straighten out a metal hanger using pliers. Wire strips might be necessary to snip off the tightly curled end of the hanger that wraps around the "neck" of the hanger.
4. Coil the hanger snugly around the glass jar, starting at the bottom and winding up to the middle or top third of the jar. The wire does not have to be tightly coiled. The hanger will act as a holder for the jar. Leave several inches of the wire straight at one end.
5. Find a level area in the yard and poke the straight end of the wire into the ground to secure the rain gauge jar. Alternatively, bend the straight end of the wire into a hook and hang it on a wall. When it rains, check the gauge to see how many inches fell.

Table 3: World Maximum Observed Rainfalls*

Duration	Millimeters	Location	Date
1 min	31.2	Unionville, Maryland	July 4, 1956
5 min	63.0	Porto Bello, Panama	November 29,1911
8 min	126.0	Fussen, Germany	May 25, 1920
15 min	198.1	Plumb Point. Jamaica	May 12, 1916
20 min	205.7	Curtea de Arges, Romania	July 7, 1889
42 min	304.8	Holt, Missouri	June 22, 1947
9 hours	1086.9	Belouve, Reunion	February 28, 1964
12 hours	1340.1	Belouve, Reunion	February 28-29, 1964
24 hours	1870.0	Cialos, Reunion	March 15-16, 1952
2 days	2499.9	Cialos, Reunion	March 15-17, 1952
7 days	4110.0	Cialos, Reunion	March 15-19, 1952
15 days	4797.6	Cherrapunji, India	June 24-July 8, 1931
31 days	9300.0	Cherrapunji, India	July 1861
2 months	12766.8	Cherrapunji, India	June-July 1861
6 months	22454.4	Cherrapunji, India	April-September 1861
1 year	26461.2	Cherrapunji, India	August 1860-July 1861
2 year	40768.3	Cherrapunji, India	1860-1861

*Daily Weather Map, 13 December 1962; J.L.H. Paulhus, "Indian Ocean and Taiwan Rainfalls Set New Records," *Monthly Weather Review*, 93, 5(May 1965), 335
(From General Climatology, Third edition, Howard J. Critchfield, Prentice–Hall of India Private Limited, New Delhi, 1975, page 66)

Whether it is in the form of rain or snow, precipitation is measured and expressed in terms of depth or thickness of layer it would form on the horizontal surface of the earth

IMD provides technical advice to State Governments on all matters connected with rainfall registration, such as selection of sites and installation of rain gauges

counting the number of 'clicks' in a 10-minute period the observer can decide the character of the rain. Modern tipping rain gauges consist of a plastic collector balanced over a pivot. When it tips, it actuates a switch (such as a reed switch) which is then electronically recorded or transmitted to a remote collection station.

The tipping bucket rain gauge is especially good at measuring light-to-medium rainfall. During a very light shower, rain collected in a bucket might not be sufficient to tip it and could evaporate before more quantity of rainfall is added. During occurrence of very heavy rain events, such as thunderstorms, water may continue to pour into the bucket while it is emptying, before the next bucket moves into place. As a result, the tipping bucket rain gauge underestimates the rainfall.

Failure can also result from the tipping mechanism getting jammed, often by a spider's web. In addition, hail, snow, birds' nests, insects, spiders' webs, and leaves may block the funnel, leading to overflow. For this reason, it is common to place two independent gauges side by side, so that errors can be quickly detected and corrected.

3. *Natural siphoning float type self-recording rain gauge (SRRG):* It is widely used in observatories of IMD and is a very useful instrument. It is made of galvanized iron sheet of 12 gauge or of FRP (Fiber glass reinforced polyesters) body most preferably being non-rusting.

The funnel here acts as a lid and is provided with a slit or window through which recording chart can be observed from outside. The rainwater collected by the funnel is poured into a float chamber through a filter. The float chamber is a cylindrical vessel with light hollow copper or plastic float inside. The upper side of the float is connected with a float rod. The other end of the float rod is attached with a pen arm, which moves on a graph paper wrapped around the clock-driven rotating drum. The clock makes one rotation in 24 hours. A special device for siphoning is provided in the float chamber, which operates automatically when the float chamber is full and empties the float chamber making it ready for the next recording.

So, the next time you come across statements in television, radio, or newspapers such as: *'Chennai recorded 3 cm of rainfall', 'The normal rainfall of this year will be around 100 cm'*, remember, a lot of scientific work has gone in before the small amount of rainfall could be worked out.

There are a number of steps involved such as deciding the number of rain gauges in an area, selecting the site for installation, actual installation, measuring the rainfall accurately and reporting the same in real time, sending the statistics every month, analysis and determination of statistical parameters etc. Further, periodic inspection, maintenance and replacement of defective rain gauges is a continuing process.

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The Melting Arctic

The Arctic zone, the crown of the North Pole and ultimately of the entire earth, may well be lost to history in the coming future. A recent report has found that the permanent Arctic ice cap is dwindling to a record low presaging a future of long summertime, Northwest passage and obscuring fog.

The study is attributed to Dr. Mark Serreze, a senior research scientist at the US National Snow and Ice Data Centre in Boulder, Colorado, USA who has been studying the overall climatic impacts and the changing moods of the Arctic since 1979. According to the study, the ice that melted through the Arctic summer is going to cover the world's northern most oceans once again. The ice cover over the entire Arctic in the summer of 2008 was slightly more than 1 million square miles, much smaller than the long-term average.

Dr Serreze along with his pool of scientists used satellite pictures since 1979 to map the extent of rise and downfall of Arctic ice cover. The present summer sea ice shattered the previous record for the smallest ice cap of 2.05 million square miles or roughly 5.31 million square kilometers in 2005, a loss of sea ice area equivalent to the states of California and Texas combined.

Due to the result of atmospheric patterns that both warmed the air and reduced clouds a process generally known as the thermal expansion of sea has increased the residual heat in newly exposed ocean waters and has thus opened the Northwest passage in the Arctic putting its marvelous wild life at stake. The polar bears along with their other endangered wild friends like the Arctic seals, walruses, Arctic fox, etc. are breathing their last.

In fact, a German expedition on the icebreaker *Polarstern* has revealed that the existing Arctic sea ice in the centre of the ice cap is only about three feet (one meter) thick, 50% thinner than it was six years ago. As a result more melt water is mixing with the salty seawater and pulses of warmer Atlantic seawater have intruded into the Arctic Ocean. Scientists are warning that if environmental vandalism by man on this delicate ecosystem continues without any impediment then it might lead to ice-free summers in the Arctic with droughts in western U.S. and changes in precipitation patterns across entire Europe and in some parts of Asia.

Contributed by Mr Rahul Rohitashwa, Secretary (Earth Matters Nature Club), Flamingo Vihar, Laheri Tola, Bhagalpur-812002, Bihar

Eat Dark Chocolate

A compound in dark chocolate may protect the brain after a stroke by increasing cellular signals already known to shield nerve cells from damage, new research shows. The amount of dark chocolate people would need to consume to benefit from its protective effects remains unclear. However, people shouldn't take this research as a free pass to go out and consume large amounts of chocolate, which is high in calories and fat.

Cold Adaptations in Sperm Whales

A group of researchers working on sperm whales have found that triacylglycerols found in abundance in the whales help them adapt to the varying depths of the sea. The head of sperm whales is very large, accounting for over one-third of its total body weight and about 90% of the weight of the head is made up of spermaceti organ. The spermaceti organ is a blubbery mass that contains up to to 3600 kg or about 4 tonnes of spermaceti oil, which is a mixture of triacylglycerols and an abundance of unsaturated fatty acids.

The researchers found that this mixture remains liquid at the normal resting body temperature i.e., about 37°C, but as soon as the temperature drops to 31°C the spermaceti organ becomes solid. Now, whales feed almost exclusively on squid in very deep water. In their feeding dives they descend up to 1,000 m to 3,000 m where the water becomes much colder and denser. At this temperature

Indigenous Climbing Tree

Bauhinia vahlii (Maljhan; Malu and Maul etc.) is an evergreen broadleaved, climbing tree of India. You will come across its leaves at every third *'Chat Bhandar'* on the roadside in your city. Its leaves are stitched together and make excellent *pattals* for a variety of purposes. The *pattals* are also considered pious in Hindu religious ceremonies. The commercial collection of leaves of Bauhinia is carried out in Madhya Pradesh, Orissa and Andhra Pradesh on a large scale.

Belonging to the family *Caesalpinaceae*, Bauhinia, also called maljhan, has a recoiling tendril to climb over adjacent plants. Leaves of the maljhan look like camel's footprint and are 40-45 cm across in size. It is rarely cultivated on the farmlands because of its handsome natural occurrence. Mostly it occurs throughout Asia, from Burma to Afghanistan. It prefers tropical and sub tropical climatic zones and grows into a medium-sized tree but shows bushy appearance in sub-Himalayan region up to 300 m above sea level.

The plant sheds its mature leaves in autumn and sprouts in the spring season. Flowers are yellowish white in colour. The flowering season varies with climatic conditions, but generally it is April to June and the fruiting season is from October to December and ready to harvest in January-February. The fruits are pods. The plant propagates naturally by seeds and shows 90% germination (based on a personal experiment) in fields.

During dry season its leaves are the best-preferred fodder for livestock. And in the farmlands the foliage is used as mulch for protecting young seedlings. Its twigs and leaves are also used in rural craft for making caps, umbrellas, *machans* (temporary roofing) and containers for raw sugars etc.

Yellowish white flowers of Bauhinia vahlii

Pods of Bauhinia vahlii

Its tender pods are collected and roasted for a dessert. Mature seeds are roasted with mustard oil or eaten raw for less expensive protein sources. Its bark provides very strong fibre, which is put to multifarious uses. Within some communities the root and dried bark is powdered and the paste is applied externally for healing bone fracture and burn injuries by traditional medicinal practitioners.

But the profuse occurrence of the plant in natural forest cover kills its host plant. It also makes the soil dry and hinders the germination of other valuable forest species. In agroforestry practices it can be used as a prominent soil binder to prevent frequent landslides on slopes.

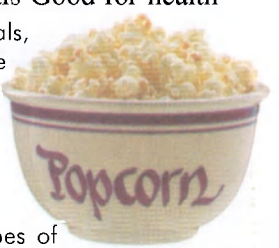
Today, the use of plastic wares has replaced these natural and biodegradable materials. There is a need for scientists and researchers to explore this plant resource and develop guidelines for proper scientific utilization.

Contributed by Mr Yogesh Gairola, 144/7, Akashdeep Colony, Ballupur Road, Dehradun-248001; gairolayogesh@yahoo.co.in

the spermaceti oil crystallizes and becomes denser balancing the density of the whale with that of the seawater. As the whale returns to the surface the crystallized spermaceti oil warms and melts decreasing the density of sperm whales to match that of the surface water once again.

Contributed by Mr Rahul Rohitashwa, Secretary (Earth Matters Nature Club), Flamingo Vihar, Laheri Tola, Bhagalpur-812002, Bihar

Popcorn & Whole Grain Cereals Good for health



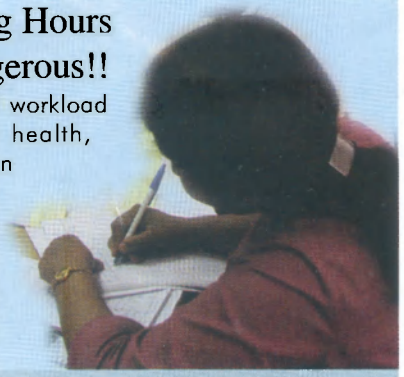
Popcorn and other whole grain cereals, including popular breakfast cereals like porridge, oatmeal etc., are regarded as healthy snacks. A recent study reiterating it has revealed that popcorn and whole grain foods contain surprisingly large amounts of polyphenol.

Polyphenols are actually types of antioxidants that remove free radicals – the chemicals that can cause damage to the body cells and tissues – from the body. This scavenging property of polyphenols protects the body from heart disease, cancer and other ailments.

Joe Vinson of the University of Scranton in Pennsylvania, who is the study's lead author, found in collaboration with his colleagues that the whole grain foods have such levels of antioxidants per gram as fruits and vegetables. Besides fruits and vegetables polyphenols, incidentally, are also present in other foods like chocolate, wine, coffee and tea.

Contributed by Dr P.K. Mukherjee, 43, Deshbandhu Society, 15, Patparganj, Delhi-110092

Working Long Hours Could be Dangerous!!



Increasing amount of workload could damage your health, researchers from London have recently found. The researchers suggest that people working 10 or 11 hours a day are more likely to suffer serious heart problems, including heart attacks, than those who get over after seven hours.

The finding further suggested that there were 369 cases of death due to heart disease, non-fatal heart attacks and angina among the London-based study group – and the risk of having an adverse event was 60% higher for those who worked three to four hours overtime

Currently, at least two million people in the UK are seriously ill or sick as a result of something that has happened to them at work and every year over 400 people are killed in workplace accidents. The higher incidence of heart problems among those working overtime was independent of a range of other risk factors including smoking, being overweight or having high cholesterol.

Some population studies have also found that people who work excessively long days generally report a lower level of perceived general health, increased rates of injury, increased psycho-vegetative and muscular disorders, are generally more frequently ill, are likely to engage in more risky health behaviour, and even have a higher mortality rate

Long working hours can affect the employees' health and wellness in many ways:

- Employees can become exhausted, demotivated and dissatisfied
- Produce less work and/or lower quality work
- Develop an array of minor ailments and become more prone to illness increasing the likelihood of sick leave which can become a major drain on the business
- Feel guilty if they don't work long hours and so become distracted and disillusioned
- Develop symptoms of workplace stress, possibly leading to serious ill-health down the track
- Not have enough time to spend with partners and children so their personal relationships and well being can suffer
- Feel forced into making unfair and unrealistic choices between demonstrating dedication to the job and giving time to their families
- Believe they will be perceived as lacking commitment if they ask for time off or will forfeit any possibility for advancement at work if they speak up and ask for a reasonable balance
- Are unlikely to feel respect for their employer over the long term
- Eventually give up and resign which can represent a loss of valuable talent for the employer and create more staff replacement costs.

So, it is for the employer to understand that having employees work more and longer hours may not necessarily result in qualitative work always, in fact, the opposite is quite likely to occur!

Contributed by Ms Himani Singh, 7/57, IInd Floor, Old Rajinder Nagar, New Delhi-110060

News Briefs

- Particular parvoviruses normally infect rodents, but they are also infectious for human cells. These viruses have an astonishing property: they kill infected tumour cells without causing any damage to healthy tissue. In those animals in which the viruses had been injected directly into the tumour, the tumours shrank visibly after only three days and even disappeared completely in eight of twelve animals treated. Therefore, scientists have been investigating over the past years whether these viruses can be used as weapons against cancer.
- Scientists have reported the development of the first "dipstick" test for instantly determining a person's blood type. The prototype paper test strips are impregnated with antibodies to the antigens on red blood cells that determine blood type. In lab tests using blood samples from human volunteers, the scientists showed that a drop of blood placed on the strip caused a colour change that indicated blood type. The results were as accurate as conventional blood typing.

- The eyes may or may not be windows to the soul, as the old adage goes, but scientists are reporting evidence that a peek into the eyes of cattle may become the basis for a long-sought test to detect infection with the agent that causes Mad Cow Disease. That test could help prevent the disease from spreading in the food supply. The scientists showed that retinas of sheep infected with scrapie, a disease similar to Mad Cow Disease, emit a characteristic glow when examined with a beam of light from a special instrument.

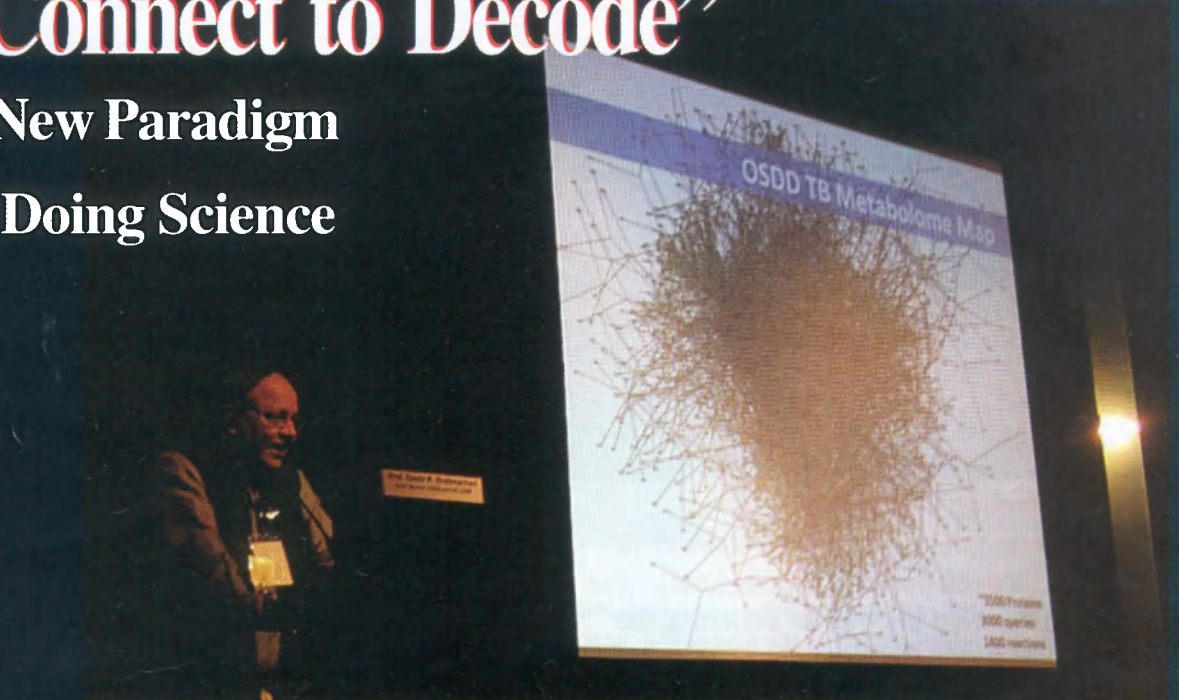
- Researchers have managed to sequence the genome of the bacteria responsible for tuberculosis in the olive tree. The sequencing of the genome of this pathogen opens the doors to the identification of the genes responsible for the virulence of this bacteria and its survival on the philosphere (leaf surface), thus facilitating the design of specific strategies in the fight against the disease and enabling drawing up programmes for the genetic improvement of olive groves.
- Astrophysicists at UC Santa Barbara are the first scientists to identify two white dwarf stars in an eclipsing binary system, allowing for the first direct radius measurement of a rare white dwarf composed of pure helium. Brief eclipses were discovered during observations of the star NLTT 11748. NLTT 11748 is one of the few very low mass, helium-core white dwarfs that are under study for their brightness variations. These observations led to the confirmation of an important theory about white dwarf stars.

- When loaded with an anticancer drug, a delivery system based on a novel material called nanosponge is three to five times more effective at reducing tumour growth than direct injection. The tiny sponges circulate around the body until they encounter the surface of a tumour cell where they stick on the surface (or are sucked into the cell) and begin releasing their potent cargo in a controllable and predictable fashion.

"Connect to Decode"

A New Paradigm of Doing Science

SUKANYA DATTA



C2D demonstrates the power of people to connect through the Internet, particular young people, and accomplish complex research tasks. This exercise has provided a large number of clues towards obtaining a comprehensive view of the microbes as a whole, producing several testable hypotheses that can now be verified in the laboratory.

ALMOST at the dawn of its creation in 2008, the Open Source Drug Discovery (OSDD — http://www.osdd.net) programme, which is a CSIR-led Team India consortium with global partnership, had identified *Mycobacterium tuberculosis* (*Mtb*) as its first target. The reason is not far to seek. With a history going back to prehistoric times, TB has stalked the Earth for millennia, claiming Pharaohs of ancient Egypt as well as Poets of contemporary times. However, despite all our grand advances in science we have failed to wipe it off the face of the globe.

Fortuitously for us, however, the IT-revolution in the early days of the twenty-first century has powered Genomics research such that looking at genomes has become easier. Rational drug discovery hinges on knowing the best target to attack, the best pathway to exploit and to do so while wasting a minimum of resources, including time. Knowing the genome is now the first step to knowing how to control a pathogen.

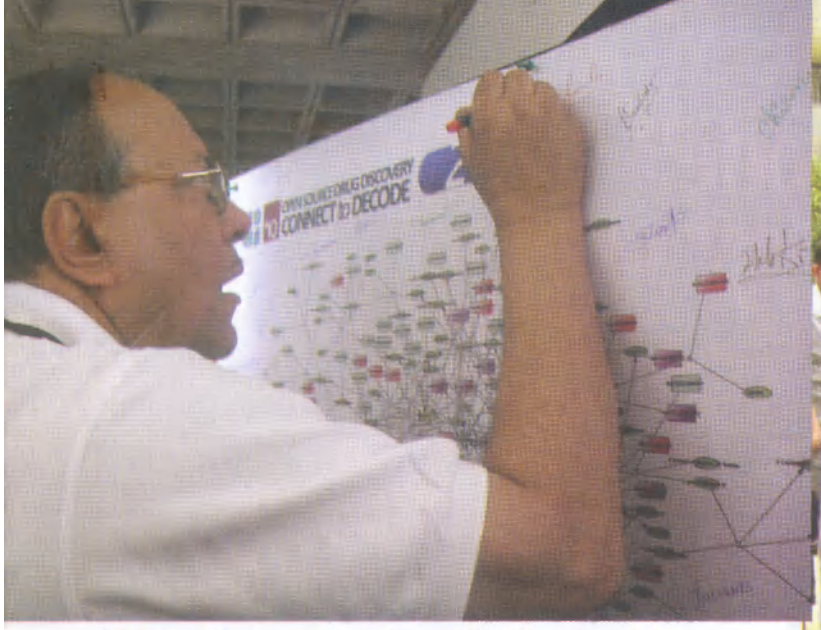
The time was ripe to take advantage of the available technology and to signal a change in the way drug development takes place. It was time to shift to rational drug development instead of a hit-and-miss approach. It was against this backdrop that the *Connect to Decode* (*C2D*) (http://c2d.osdd.net) initiative of the OSDD was announced. It was designed to meet the challenge of annotating all possible genes in *Mtb*.

Diagnostics, Vaccines & Drugs

It is unfortunate that TB which has high mortality but low profitability (because it is a "disease of poverty") is neglected by the current system of pharmaceutical research. Virtually no new TB drugs have been developed since the 1960s. Thus, our arsenal of weapons against TB is woefully dated.

C2D demonstrates the power of people to connect through the Internet, particular young people, and accomplish complex research tasks.

Director General, CSIR, Dr Samir Brahmachari with young scientists



OSDD will share through a globally accessible database to any research institutions involved in TB research through its open portal (www.osdd.net). The annotation has paved the way for enriching the genome study even further through open collaborations. More importantly, the data is available for effective application in rational drug discovery.

Our diagnostics and vaccines are equally inadequate. While Sputum Microscopy was developed in 1882, Mycobacterial culture came into being in 1882 and Chest X-ray in 1896. Besides, the sole vaccine available is the Bacillus Calmette-Guerin (BCG) vaccine developed in 1921. It has limited efficacy in preventing Tuberculosis.

Dr Samir Brahmachari, DG, CSIR, with Mr. Prithviraj Chavan, Minister of State for Science &Technology and Earth Sciences

TB, HIV & Drug Resistance

Combating TB has become even more difficult because of TB's deadly relationship with HIV.

- TB accounts for up to a third of AIDS deaths worldwide.
- In some countries with high HIV prevalence, up to 80% of people with TB test positive for HIV as well.
- Complicating the already complex scenario is the fact that drug-resistant varieties of *Mtb* are spreading.
- Multi-Drug Resistance (MDR) is rampant in many parts of the world and Extreme Drug Resistance (XDR-TB) is now reported in more than 45 countries.

The organism lies dormant in the body once it infects and evolves swiftly; so, the strategies to defeat it must be novel too. It is clear that without an understanding of the molecular secrets embedded in the organism's genome, identification of its soft underbelly is impossible. We

Take a Look at TB

- Bones showing signs of tubercular infection have been found since the Neolithic period (~3000–7000 BC).
- On 24 March 1882 Dr. Robert Koch identified the causative organism.
- India accounts for one-fifth of the global TB cases.
- Nearly 2 million people in India develop TB annually, of which around 0.87 million are infectious cases.
- Two people die of TB every three minutes in India.
- No country is TB-free. TB is a worldwide pandemic; about one-third of the world's population is infected with TB.
- New infections occur at a rate of one per second. 5-10 per cent of those infected develop full-blown Tuberculosis later.
- Left untreated, each person with active TB disease will infect, on average, between 10 and 15 people every year.
- WHO reports that 1.7 million people die annually from TB.
- In some areas of the world, one in four people with TB becomes ill with a form of the disease that can no longer be treated with standard drugs regimens.
- Global incidence of TB is increasing by 0.6% per annum.

must find new points of vulnerabilities which we can attack. New drugs and vaccines are vital.

Also, it is important to approach the problem with a Systems Biology perspective of the pathogen in mind. Systems Biology is the integrated approach to studying biological systems. Instead of studying proteins one at a time as used to be the traditional way of looking at cells, Systems Biology looks at the larger picture. For example, it studies intracellular networks, cells, organs, and biological entities by measuring and integrating data gathered at the genetic, proteomic and metabolic levels. This approach involves the study of cellular and pathway events, which by virtue of their roles are usually in a state of flux. Many are also interdependent.

The Systems Biology approach to drug discovery relies also on using clinical samples from diseased as well as healthy people. This study helps uncover Systems Biology Markers, which are the footprints (so to say) of genes and Pathways Targets. These act as indicators of disease and are potential targets for therapeutic intervention. In a way, the Systems Biology approach acts like a spy who has integrated into the community and has intimate knowledge of all that is happening there. Rarely can such knowledge fail to yield results.

There is no doubt that tackling TB effectively requires addressing all the risk factors that make individuals vulnerable to infection with *Mycobacterium tuberculosis* and to developing the disease. It also calls for new drug targets and more potent, less time-consuming drug regimes.

This is where C2D stepped in because the role of functional genomics in modern drug discovery is to prioritize targets and to translate that knowledge into rational and reliable drug discovery. Of course, polymorphisms among *Mtb* strains are quite extensive and genetic variation may have an important role in disease pathogenesis and immunity. So, annotation is where the journey begins.

Connect 2 Decode (C2D)

C2D was launched as a massive initiative aimed to further the understanding of the biology of *Mycobacterium tuberculosis*. In the words of the scientists working hands-on, it was an attempt to enrich the annotation of the *Mycobacterium tuberculosis* genome. The plan was not to just take a closer look at the thousand or so genes that had already been annotated (to re-annotate if necessary) but to annotate the whole genome of 3998 genes, including the yet un-annotated genes too.This also involved re-annotating the Immunome and Glycome of the deadly bug as well as looking at structural models of the 4000 odd proteins.

Preparation of one of the most comprehensive metabolic pathway maps of the organism by manually curating the data, applying various computational tools and also by integrating post-genomics datasets on *Mtb* was on the cards. This would be the first step to accelerated discovery of novel drugs for TB. There was a sense of urgency to the work and the deadline when this would be actually achieved was announced well ahead of time.

Mtb Genome and Beyond

The genome of *Mycobacterium tuberculosis* H37Rv strain was sequenced in 1998 and reported in the 11 June 1998 issue of the journal *Nature*. This work by Stewart Cole and his group remains the foundation stone of TB research. The advent of the science of Genomics heralded an era of hope. It was hoped that the decoding of the microbial genome would lead to the identification, and subsequently, the exploitation of the genetic vulnerabilities of the microbe. It was also hoped that decoding the *Mtb* genome would lead to the identification of more precise drug targets and, thus, more potent pharmaceutical products. It was hoped that soon the Earth would be free of this scourge. *Unfortunately, that did not happen.*

Till date, the standard databases have annotated only about 1000 of the near 4000 genes encoded by the organism. The rest of the genes languish in apathy...and new and potent drugs for this killer disease await discovery that seems light-years away for those whose very existence is threatened by active infection with TB. With only a quarter of its genetic secrets known in any detail, it is hardly surprising that no new drugs/drug targets have been ferreted out of this genetic treasure trove. This is symptomatic of the problem of neglected diseases of the poor...and a case replicated all over the globe.

However, initially when the genome sequence of *Mtb* was deciphered, it did trigger intense research on the pathogen. Soon the first annotation came out. It provided the first "parts list" of the microbe. A re-annotation carried out subsequently identified more parts, completing the list of proteins coded by the genes of *Mtb*. Unfortunately, it was at this point that the interest seems to have lost steam.

C2D Phase II

The C2D Phase II is also now on. Those interested may log on to http://c2d.osdd.net

Very little, if any at all, work was done with a Systems Biology approach in mind. That is to say, no research was done on how these "parts" are "assembled" in the cell. Now, obviously, to do this, the description of each "part" must be known in as much detail as possible. Any new scientific work usually builds on the edifice of past research. So, the OSDD researchers began by scanning existing literature. They found a wealth of experimentally derived data on various proteins of *Mtb*. They were helped in this by IT and knowledge-driven tools that were helpful in enriching the annotations. However, the information was scattered, buried deep and needed to be extracted if it was to be used meaningfully.

The C2D Strategy

The initial requirement was for a large pool of workers to scrutinize available literature, use computational tools and collate this information. With a global community of nearly 3000 members from 74 countries, OSDD is a community of scientists, doctors, students, policy experts, software professionals, research students and others united in the quest to defeat TB.

Recruiting Raw Talent and Mentoring Merit: Finding willing volunteers was the least of the worries. The day registration to C2D was opened, over a 100 volunteers signed in; subsequently the numbers peaked at 800. The Faculty drawn from the best Institutions included: Dr. G. P. S. Raghava (Institute of Microbial Technology, Chandigarh, CSIR); Dr. Nagasuma Chandra (Indian Institute of Science, Bangalore); Dr. Debasis Mohanty (National Institute of Immunology, New Delhi); Dr. Samik Ghosh (Systems Biology Institute, Japan); Dr. Sulagna Banerjee (AU-KBC); Dr. Anshu Bhardwaj (Institute of Genomics and Integrative Biology, Delhi, CSIR); and Dr. Vinod Scaria (Institute of Genomics and Integrative Biology). The participants were also from all over the country, from Kashmir to Kerala and from Gujarat to West Bengal.

Mapping the Work: The C2D initiative leveraged this huge strength to tackle the *Mtb* genome from five different angles. The first, called TBGO, obtained associations for each gene with function(s). This exercise has provided a large number of clues towards obtaining a comprehensive view of the microbes as a whole. It has presented several testable hypotheses that can now be verified in the laboratory. The annotation has been made available on a public portal, paving the way for enriching it even further through open collaborations. More importantly, the data is currently available for effective application in rational drug discovery.

Second, each protein was studied at high resolution by modeling their three-dimensional structures, through which higher order clues about their functional roles are obtained.

Third, proteins which interact with various sugars or carbohydrates in the cell were deciphered; these are believed to be important for the signaling events in the cell, somewhat akin to the switches.

Fourth, the assembly of the parts was sought out by identifying those parts that talk to each other directly and those parts that talk to others through mediators, such as metabolites.

Integrating data from all the angles, or network of the parts list was reconstructed, in which functional modules (or biochemical pathways) were also identified. The network helps in understanding how metabolism takes place in the bacterial cells, how it compares with humans and with other bacteria. It also helps in answering questions about what strategies should be adopted to kill the bacteria. This helps fashion a strategy for drug design.

A fifth theme that was pursued was to identify proteins that contain antigenic parts in them that could trigger immune responses in the host and thus ultimately help in rational vaccine design.

The C2D Experience

The project was implemented in an extremely cost- and time-effective manner and by tapping into a huge pool of raw, young talent. Student volunteers were inducted into the programme and trained over a period of about four months. Their work was monitored online by the respective Principal Investigators. Stringent quality control measures were put in place to verify and correct the annotations made by students in various places. The volunteers pooled their time and skills, using online tools, to provide insights into all the genes of *Mtb*..

Their work is held in a shared database, which OSDD will share through a globally accessible database with any research institutions involved with TB research through its open portal (www.osdd.net). The annotation has paved the way for enriching the genome study even further through open collaborations. More importantly, the data is available for effective application in rational drug discovery.

C2D demonstrates the power of people to connect through the Internet, particular young people, and accomplish complex research tasks. It is also a distinct move from a hierarchical based model of doing science towards one of equal collaboration.

This exercise has provided a large number of clues towards obtaining a comprehensive view of the microbes as a whole, producing several testable hypotheses that can now be verified in the laboratory.

Dr. Sukanya Datta, Scientist NISCAIR, posted to Director General's Technical Cell, CSIR-HQ
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SOLAR RADIATION

NEERAJ KUMAR

1. **Solar radiation is produced by which process?**
   a. Adiabatic process b. Nuclear fusion
   c. Photoelectric effect d. Chaos process
2. **Solar energy travels to space in discrete packets of energy known as...**
   a. Photon (Electromagnetic wave) b. Boson
   c. Fermion d. Meson
3. **What is solar constant on earth?**
   a. 100 Langley b. 2.0 Langley
   c. 22 Langley d. 2.987 Langley
4. **A coronal mass ejection in sun with an explosion in the corona pushes millions or billions of metric tons of material out into space and is known as...**
   a. Solar wind b. Solar earthquake
   c. Solar flare d. Solar break
5. **A form of energy that is emitted by all objects having temperature above absolute zero is known as?**
   a. Light b. Radiation
   c. Electromagnetic wave d. Wavelength
6. **What is the wavelength of visible solar radiation?**
   a. 400-700 nm b. 1000 nm
   c. 100-150 nm d. 2.13-5.0 nm
7. **Which law states that a good absorber of radiation is also a good emitter under similar conditions?**
   a. Planck's law b. Kirchhoff's law
   c. Stefens's law d. Weins's displacement law
8. **Which one of these wavelengths has maximum energy?**
   a. 0-300 nm b. 400-430 nm
   c. 1000 nm d. 189000 nm
9. **Solar radiation is measured by?**
   a. Pyranometer b. Pyrheliometer
   c. Pyradiometer d. Radiometer
10. **A certain part of energy received from the sun and reflected back to space by the earth is known as...**
    a. Transmission b. Absorption
    c. Albedo d. Conduction
11. **The total of all incoming and outgoing radiations over the earth's surface is called...**
    a. Energy balance b. Heat movement
    c. Metabolic heat d. Mutagenesis
12. **The amount of electromagnetic energy incident on a surface per unit time per unit area is known as...**
    a. Irradiance b. Fallout
    c. Radioactivity d. Momentum radiation
13. **By which process do green plants and certain other organisms use the energy of light to convert carbon dioxide and water into the simple sugar glucose?**
    a. Transpiration b. Detoxification
    c. Photosynthesis d. Respiration
14. **Solar cells made from thin slices of crystalline silicon, gallium arsenide, or other semiconductor materials convert solar radiation directly into electricity and are known as...**
    a. Photovoltaic cell b. Silicon chip
    c. Wind vane d. Saleometer
15. **According to which law the energy flux density of radiation from a body is a function of the fourth power of its absolute temperature?**
    a. Planck's law b. Kirchhoff's law
    c. Stefens's law d. Weins's displacement law
16. **In which process the high-energy radiations viz., ultra-violet, X and gamma radiation have damaging effect on living cells?**
    a. Mutagenesis b. Mutation
    c. Clone d. Mimic
17. **In physics, which theory reveals description of the particles that make up matter and how they interact with each other and with energy?**
    a. Quantum theory b. Newton's theory
    c. Acrimonies theory d. Planck's theory
18. **When small particles and gas molecules diffuse part of the incoming solar radiation in random directions without any alteration to the wavelength of the electromagnetic energy, this is known as...**
    a. Scattering b. Reflection
    c. Absorption d. Isolation
19. **Solar radiation that reaches the Earth's surface after being altered by the process of scattering is called...**
    a. Diffused solar radiation b. Incoming solar radiation
    c. Outgoing solar radiation d. Terrestrial radiation
20. **When ionized radiation strikes living tissue and damages the molecules of cellular matter this process is known as...**
    a. Biological radiation effects
    b. Chemical radiation effects
    c. Climatic radiation effects
    d. Physical radiation effects

ANSWERS:

1. b	2. a	3. b	4. c	5. b	6. a	7. b
8. a	9. a	10. c	11. a	12. a	13. c	14. a
15. c	16. a	17. a	18. a	19. a	20. a	

Contributed by Shri Neeraj Kumar, Research Scholar, Department of Agrometeorology, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand-263145; Email: neeraj34012@gmail.com

GENOMICS

MOHAMMAD IMRAN KOZGAR

1. The term Genomics was given by
a. G. J. Mendel b. R. Sturvert
c. Watson and Crick d Thomas Rodric

2. In April 2003, which of the following projects was completed
a. Human Genome Project b. Rice Genome Project
c. Both (a) and (b) d. None of the above

3. Active sites in protein are
a. Non-binding sites b. Potential site
c. Binding sites d. Both (a) and (c)

4. Reverse transcription is...
a. Synthesis of mRNA from DNA
b. Synthesis of DNA from tRNA
c. Synthesis of tRNA from DNA
d. Synthesis of DNA from mRNA

5. Genomics is the study of
a. Complete set of genome
b. Total genetic content (in cell)
c. Total genes (on chromosome)
d. All of the above

6. SNP stands for
a. Short Non-binding Proteins
b. Short Native Proteins
c. Single Nucleotide Polymorphism
d. None of the above

7. Micro array technology is used in
a. Toxicity testing b. Toxicity mechanism
c. Both (a) and (b) d. None of the above

8. Genetic traits refer to similarity of
a. Knowledge characteristics
b. Mental characteristics
c. Physical characteristics
d. None of the above

9. Molecular Docking is...
a. Gene-Gene interaction
b. Gene-Protein interaction
c. Protein-Protein interaction
d. All of the above

10. ... & .... are two types of phylogenetic tree
a. Dendrogram, Cladogram
b. Dendrogram, Phylogram
c. Cladogram, Phylogram
d. Dendrogram, Histogram

11. Introns are present in
a. Prokaryotic Genome b. Eukaryotic Genome
c. Both (a) and (b) d. None of the above

12. Functional genomics deals with the study of
a. Functions of all genes b. Structure of all genes
c. Sequencing of all genes d. None of the above

13. Gene prediction is done by which of the following methods?
a. Similarity search method b. ab initio method
c. BLAST d. All of the above

14. An allele is
a. Homozygous genotype
b. Heterozygous genotype
c. Another word for a gene
d. One of several possible forms of genes

15. The field that is concerned with the management and analysis of biological data using computers is
a. Bioinformatics b. Genomics
c. Statistics d. Proteomics

16. .....genomics studies similarities and differences among the genomes of multiple organisms?
a. Structural b. Functional
c. Comparative d. None of the above

17. Which type of genomics studies the transcripts and proteins expressed by a genome?
a. Structural b. Functional
c. Comparative d. None of the above

18. Which type of genomics studies the physical nature of genomes?
a. Structural b. Functional
c. Comparative d. None of the above

19. Evolutionary genomics seeks to answer questions about...
a. Use of DNA profiles to identify evildoers
b. History of each species' genome
c. Development of genomic sequencing techniques
d. None of the above

20. The identification of drugs through genomic study is
a. Cheminformatics b. Genomics
c. Pharmacogenetics d. Pharmagenomics

ANSWERS:

1. d	2. a	3. c	4. d	5. d	6. c	7. a
8. c	9. c	10. c	11. b	12. a	13. d	14. d
15. a	16. c	17. b	18. a	19. b	20. d	

Contributed by Mr M. Imran Kozgar, PhD Scholar, Department of Botany, Aligarh Muslim University, Aligarh-202002; Email: m.i.kozgar@gmail.com

"Politics and Crime Are Given More Coverage In The Media Than Science"

Not Much Happening in Science

It is quite right that media gives more coverage to politics and crime. But not much is happening in the field of science, whereas in politics there is a lot happening—crime, corruption and so on. So, by showing all these the media get popularity. That is why politics and crime are given more coverage than science in media.

Ajit Kumar Mandal
M.P.C. Auto College, Baripada, Orissa

Rating Game

Nearly 38% of the people in India are illiterates. Generally they do not show interest in science related matters, which are not easy to understand. The percentage of the people who

can follow science is very small. Hence the coverage of science in the media is least. So, media people concentrate more on politics and crime news that attract the general public. Coverage in these fields helps to increase their ratings. But media authorities should have a social responsibility to promote science and scientific attitude.

P. Veeranjaneyulu
Andhra Pradesh

Eclipsed Science In Media

As a daily reader of newspapers, I hardly read any Science. If it is there at all, it is tucked away available in a corner of the paper. News channels also give

priority to games, crime and politics rather than Science. There are only a few channels like National Geography, History channel, Animal Planet, Discovery etc that are a good source of knowledge about Science but everyone does not watch them. Our channels should also carry programmes on science such as the past, present and future of Indian science, information about great scientists and so on.

Rajat Kumar Mahaych
Mahendergarh (Haryana)

Science Should Entertain People

Science is fun. It should be presented in an easy and interesting way that should entertain the people and also stress its importance in daily life. Nowadays media are competing in entertaining the people by covering entertaining issues. Science can also be brought under the ambit of entertainment.

Raghavendra
Karnataka

Illiteracy to Blame

Politics and Crime are interrelated terms leaving out Science in the cold. Science is a mixture of rational thoughts that enhances our thinking. It also helps in deeper understanding. Due to the very low literacy rate and lack of knowledge in India most people are attracted more towards the politics and crime.

Yatee Gupta
Motihari (Bihar)

For Money and Publicity!

We have seen in the newspapers and magazines that there is

more coverage of news about crime or politics. This is because the media gets more money and publicity through it. If there would be news about science the public may not like this because nowadays people are moving from the science fields towards business. The media should be asked to publish the news about science too which would be helpful for the youngsters, who are the future of this country.

Pranav Saxena
Bihar

Build a Scientific Generation

All categories of media are a part of education because media is the mirror of the society. If media focuses on new inventions then social and mental development will occur. But presently media show crime more than science; as a result criminal mentality is increasing in the youth. Media can build a generation with scientific mentality that will be a resource for the country.

Supra Dwari
West Bengal

Media not Independent

Politics and crime are given more coverage in media than science because often media channels are controlled by politicians or political parties. So, their main focus is on politics rather than science. Another reason is that people's understanding about science and related issues is very low. When media becomes independent and thinks that scientific information is necessary for developing a society and a country then they will give more attention to scientific news.

Saurav Dwari
West Bengal

Now write in your thoughts on this topic for inclusion in the forthcoming issues:

" Keeping animals in zoos is unethical." *Be brief and be logical! Send in your photo, if you like.*

"India is a very promising country with an emerging economy":

HE Mr. Koji Omi

Mr. KOJI OMI *is a key figure in the field of science and technology in Japan. He has served in various capacities in the Ministry of International Trade and Industry. He has been a member of the House of Representatives for eight terms and a Cabinet Minister with different portfolios. He promoted the founding of the Okinawa Institute of Science and Technology, an international and interdisciplinary graduate university. He also founded the Science and Technology in Society (STS) forum with the aim of building a worldwide network among scientists, policymakers and business people.*

Mr. Koji Omi visited India during March 2010 and met political and economic leaders, academicians and left with high hopes of cooperation between the two countries. **Er. ANUJ SINHA**, *Consultant, Department of Science & Technology, Govt. of India and Director, Vigyan Prasar interacted with Mr. Koji Omi, during his visit to India. Here are some of the highlights of the interaction:*

ANUJ SINHA: Welcome to India. Sir, in the past many years you have led various developmental efforts in Japan. You are also a very good friend of India. India is a large country with a large percentage of young people. What are your expectations from the Indian society?

KOJI OMI: We look upon India as a very promising country with an emerging economy. As a result of the open market policies that commenced in the 1990s, this country has a very promising future. India has been developing very dramatically in many fields. And of course simultaneously the people of this country are democratically supporting the government. That is very important from our point of view. We also realize that Indian people have very high level of technical attainments. We can foresee a very promising future for this country. In Asia, I feel India is the most promising and influential country.

A.S.: Thank you, Sir, for your positive comments. We have some local problems of environment, industrialisation and some global issues like climate change. There is a debate between those who are talking of development and those who are in favour of conservation. How do you view these issues?

KOJI OMI: Global warming is the most important and a serious problem for humankind. In the Science & Technology Society Forum, of which I am the founder Chairman, we feel that humankind should evolve a framework of constitutional protocol, in which all countries including United States, China, and India should participate. The Kyoto protocol covers only 30% of the CO_2 emissions (Japan and the European countries). Even if this is achieved, I don't think humankind can solve the problem of global warming, unless a majority (70%) of the world's people agrees to take concrete measures. In the 21st century, the globe has become finite and all people on Earth have to realize that. Humankind has to change the way of living and the economy has to adjust to such limitations. This is a fundamental shift in thinking. China, India, Japan and other European countries have their own limited agendas, but we are all living on one ship. We must remember we have increased in population from 6.5 billion in 20th century to 9 billion by the end of the 21st century. Humankind will have to resolve the conflict between economic development and sustainability. For reducing the CO_2 level in the atmosphere, we have to consider increasing the area under rainforests. Reduction in CO_2 emission is another solution. It is tough but we must attempt it.

A.S.: The argument at several international fora is that the per capita CO_2 emission of a country like US vis-a-vis a country like India is widely different and therefore reduction should be done more by the developed than the developing country. And this argument can go on for several years.

KOJI OMI: We understand that the emission of CO_2 is different in developed countries and developing countries. But how do we solve this matter concretely? Science & Technology only can solve this matter in some way. We have to make a new framework to reach out to all countries with equity.

A.S.: Sir, over the past few years, we have been inviting several leading universities from the US, UK and other countries to set up campuses in India. Are some leading Japanese Universities also interested? How can we promote academic interactions between the Japanese Universities and Indian scholars?

KOJI OMI: Yes! I really am very much impressed by the Indian Government that is very forward looking in education. Situations are changing dramatically in this

country with strong emphasis on education for young people. Especially, teaching at the IITs is of very high standards. This is the right way for a bright future. In my view, Japan should cooperate more eagerly in this academic opportunity. The dream of Japan is to cooperate not only in business activities, but at the academic level also. There is a very bright future if India continues this policy of educating its young.

A.S.: Are there any leading Japanese Universities in technical education, agriculture science or medical science that are thinking of setting up research centers in India? Is there any thing in the pipeline?

KOJI OMI: I think it is desirable and necessary for Japanese Institutions and Government of Japan to see the opportunity. The young people of this country have very high potential, so it is a relationship of mutual benefit. I visited IIT Delhi, Mumbai and scientific Institutions of Bangalore. The facilities, faculty and quality of teaching and research are very high for the development of not only India but also Asia in general.

A.S.: Sir, you have set up the Science & Technology Society Forum in Japan with a vision over the past few years, what have been its achievements?

KOJI OMI: When I was the Minister in charge of Science & Technology Policy in 2001, I conceived of this forum and I am here to explain our activities to the people of India and ask the leaders from the business community, academic circle and government officials to attend the next meeting. We have organised six annual meetings in Kyoto, Japan that have been attended by the Prime Minister of Japan. At the last meeting in October 2009 about 800 people from 85 countries including Noble laureates, ministers in charge of Science & Technology and academicians from leading universities participated to discuss current issues. I would like to have more participation from this country. This year our meeting will commence on October 25. We are inviting Indian leaders in our Science & Technology Society Forum's meetings this time also. We are expecting a delegation of 30 experts to attend the meeting to discuss the future of human kind. I have met Mr. Prithvi Raj Chavan, Union Minister of State for Science & Technology and Earth Sciences and Mr. Kapil Sibal, Union Minister of Human Resources and both have accepted our invitation. We really appreciate this very positive attitude of the leaders. I have bought an invitation letter for Prime Minister Dr. Manmohan Singh to attend, since he is very eager for development through Science & Technology and also in the education of the young people. I have met many leaders of CII, FICCI, industrial leaders from Mahindra, Tata, Infosys, Wipro, etc. and discussed issues of mutual interest. India will be a major leader in the next 5 to 10 years and we need to discuss about problems related to CO_2 emissions, global warming, population and other developmental issues. This country has an open society and an open economy and that is the reason for our two countries to build cooperation in the field of economic development.

A.S.: I am very happy that you have lots of confidence that Indian society will meet the challenges and expectations in future. How can we encourage Japanese industries to invest more in India?

KOJI OMI: It is estimated that the number of Japanese people working in India is about four thousand. On the other hand there are 1,20,000 Japanese in China and about 40,000 in Thailand. The number of Japanese companies in India is of the order of 700, compared to six thousand in China, 1300 in Thailand. Both the number of the people and number of companies has been dramatically increasing in

Science and Technology in Society Forum, Japan

The explosive progress of science and technology up to the 20th century brought prosperity and enriched the quality of life for much of mankind. However, the advance of science and technology raises important ethical, safety and environmental issues: possibly negative applications are threatening mankind's own future. Since progress in science and technology is expected to accelerate and will be necessary for sustainable human development in the 21st century, wisdom must be exercised to keep it under proper control.

In that sense, the most pressing problems we face today include harmonizing economic development with global warming; combating terrorism; controlling infectious diseases, and assessing the potential health benefits and ethical factors relating to cloning technology. International efforts to address these problems are needed now more than ever. This is really what symbolizes the "lights and shadows of science and technology." Opportunities need to be taken, but the risks must also be controlled. Health, meeting energy needs, and many other aspects of human welfare depend on continued progress in science and technology.

At the same time, the benefits of science and technology are not reaching a major part of the world's people. The barriers to seizing the opportunities for using science and technology to solve the problems of humankind need to be discussed. Because the problems we face today are becoming increasingly complex against the backdrop of globalization and international competition, they are beyond the control of any single country. These issues are also beyond the control of the scientific community alone, because many of the problems will find solutions through changes in social systems, international collaboration, global networks, and the building of common rules.

The time has come for not only scholars and researchers but also policy makers, business leaders and media leaders from all over the world to meet and discuss science and technology issues in the 21st century.

The Science and Technology in Society Forum aims to provide a new mechanism for open discussions on an informal basis, and to build a human network that would, in time, resolve the new types of problems stemming from the application of science and technology. The forum community will also explore the opportunities arising from science and technology, and address ways to remove the barriers to using science and technology to solve the problems facing humankind.

Forum members are expected to participate, not as representatives of their country or organization, but as individuals expressing their ideas and conveying their knowledge. Participants should also undertake cross-border activities towards the establishment of shared values and commitment for the future.

the recent decade. The leaders of Japan perceive the important role this country will be playing in the future. I am optimistic that our relations with India will register dramatic increase in a few years from now and industry presence will also increase.

A.S.: Engineers or scientists from Japan are known for their accuracy and manufacturing process with zero defects. Japanese products are known for their quality. Do you have any kind of assessment how Indian technicians, engineers and managers can develop an eye for details, insistence for quality and standards that make sophisticated products good for export.

KOJI OMI: Thank you for the high comment on our engineering and technology. Only by working together will a culture of high accuracy be achieved as in the Japanese industry. More collaboration will help.

A.S.: Sir, young people who are good in studies opt for careers in management but not in science or research. This is of concern because from where will we get teachers or researchers in future. Are there some lessons from Japan that we can learn from?

KOJI OMI: There are many avenues for young people. Some of them like to be sportsmen and some of them aspire to be actors or actresses. They are free to choose their careers themselves, but it is important that they must know which direction they are going. It is necessary to give them right education and motivate them to join universities for learning science and pursue research. There are a lot of people who would like to learn science in IISc Bangalore, IIT Delhi, etc. Some scholarship schemes have been started recently. This should help.

A.S.: Sir, we are also working in the field of science outreach and science communication. Our major challenge is disparity in society. There is a highly developed population that is very receptive to new ideas and there is a section that is illiterate. Rituals, superstitions, myths come from culture. It may also be true for Japan but not like India because the level of literacy is much higher in Japan. The role of the media, print, TV and radio has not been positive in our country because they are in the hands of the private sector and looking for entertainment for quick profits but not development. Would you like to suggest some solutions that may perhaps work?

KOJI OMI: I understand that it is a very serious problem in this country. I don't think there is any easy way to solve this. Continuing effort on the education of young people is necessary for the situation to gradually improve. Indian leaders in different fields should give the right direction. The success of Japan in the development of modern society, I told at the last conference of the forum, is because we work very hard on the issues.

A.S.: Sir, you started your career in commerce, moved to government, then the House of Representatives and were minister of several important departments. Now you have established the Science & Technology Society Forum. You have had major shifts of careers. Readers would like to know about the decisive stages in your profession and personal life. What were the major accomplishments?

KOJI OMI: When I was a government official, I was responsible for working for the economic development of Japan. And when I came to the stage of policy-making (I stayed in this for 26 years) I continued making sincere efforts. I had a major role in defining the Science & Technology Policy in 1995. I perused matters of S&T as member of the parliament, which was a rare case. Now we are developing five-year plans. This is the third such plan. It is based upon this S&T Policy we defined in 1995. I am a member of the congress even now but I concentrate my energy on this Science & Technology Society Forum that is concerned with the future of the human kind. This is very important.

A.S.: Sir, diverse people of Brazil, China, India, and Japan have different concerns, value systems, etc. Can we actually still work together and do some thing for our grand children?

KOJI OMI: We have to find solutions for the future of the human kind because natural resources are finite. Through this forum, we need to enroll everybody and persuade them to think about the future of humankind not only for us but for the next generation.

A.S.: We would like to continue to learn from you. Thank you, very much.

KOJI OMI: Thank you; I also enjoyed this discussion with you. ■

M.S.S. MURTHY

The Case of the Aging Nukes

AFTER the nuclear weapon tests by India and Pakistan in 1998, no other country has conducted such tests except North Korea in recent years. Most of the nuclear weapon countries have declared "no first use" moratorium. They deploy nuclear weapons only as a deterrent. Under such circumstances, the reliability of the weapon has to be more than 100 per cent to ensure the desired deterrence and also provide national security. However, there is a problem. Some of these warheads are more than 30 years old. Like all engineered systems, nuclear weapons also age and this puts a question mark on their reliability.

No system is engineered to sit inactive for years or decades and still be able to spring into action at just a few moments' notice. It cannot happen with a car, a TV or even a bicycle. However, that is what is expected of a nuclear weapon.

A thermonuclear weapon is a highly complex system consisting of approximately 6000 components including electrical, electronic, mechanical, chemical and nuclear packages. These various components grow old and eventually become nonfunctional. Though the aging process of many of these packages is reasonably well understood, what sets apart a nuclear weapon from other engineered systems is the aging of the nuclear package.

Nuclear Package

The nuclear package of a modern thermonuclear weapon is made up of two stages—one primary and the other secondary.

The primary stage consists of a core or a pit containing Plutonium-239 as the fissile material and a booster fusion gas—a mixture of tritium and deuterium. The secondary stage consists of another fissile material such as Uranium-235 and lithium deuteride as the fusion material. During a weapon operation, first a chemical explosive, which surrounds the primary stage, is triggered. The shockwaves produced by the exploding chemical compress the pit containing plutonium to such a density that a spontaneous nuclear fission chain reaction sets in resulting in instant explosion. The imploding plutonium also drives the booster gas to compress and undergo fusion.

The combined fission-fusion yield of the primary stage initiates further fission-fusion reactions in the secondary. It is the secondary stage that provides the bulk of the military yield.

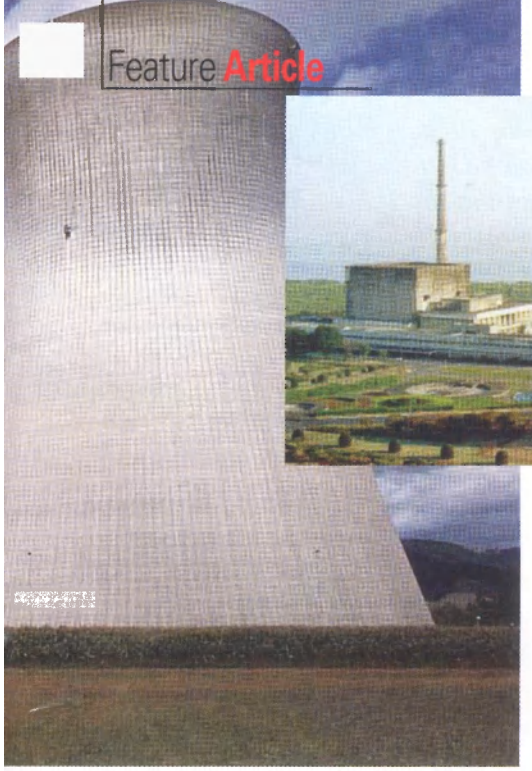
Causes of Aging

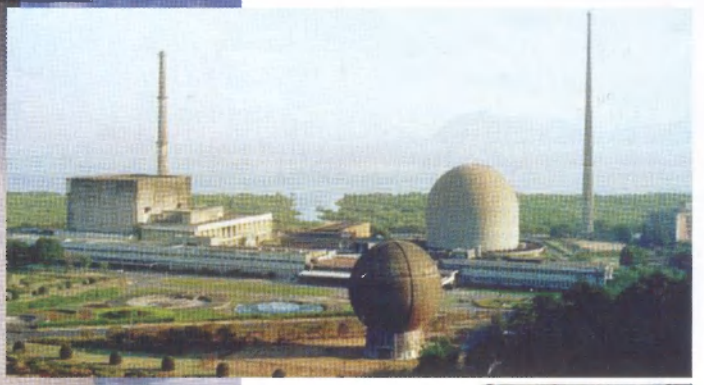
When deployed, a nuclear warhead is exposed to not only the harsh external environment, but also to several deteriorating factors from within. This is because plutonium, which is the heart of the nuclear trigger, is a highly corrosive metal. To reduce corrosiveness and improve mechanical properties, plutonium is used in the form of an alloy with a small percentage of gallium. In addition, it is radioactive. As each plutonium atom decays, it breaks down into a uranium atom and helium nucleus (called alpha particle), both of which are highly energetic. The helium nuclei eventually combine with other helium nuclei to form helium gas bubbles inside the plutonium-gallium alloy matrix.

The uranium atoms continually knock out plutonium atoms from their positions in the matrix. It is estimated that every year about ten percent of the plutonium atoms are displaced. Though most of them come back to their original positions, some are permanently displaced. In the long-term, such changes may lead to deterioration of plutonium in the form of corrosion, warping and changes in its crystalline structure.

In addition, weapon grade plutonium contains trace quantities of non-fissile isotopes of plutonium, the decay products of which also accumulate with time causing changes in the material properties of plutonium.

The organic polymers constituting the chemical explosives that surround the primary stage also deteriorate with time both on their own and due to irradiation from plutonium. Another important factor is the deterioration of the electronic components like chips, which control the fusing, triggering,





Though the weapon experts have observed certain number of age-related defects, they are of the opinion that many of them are not serious.

and detonation of the weapon, due to irradiation from plutonium. Though these components are radiation-hardened, their long-term efficacy cannot be predicted.

A crucial factor in the success of the weapon is the proper energy coupling between the primary and the secondary stages. A minimum amount of energy from the primary is required to trigger the secondary. Weapon designers generally provide, what they call, a performance margin, which is the difference between the minimum yield obtained from the primary and the yield required to drive the secondary. Subtle changes in the material properties can affect the primary stage implosion.

Hence, one of the major concerns about the aging is that plutonium deterioration due to self-irradiation and the deterioration of the chemical explosives surrounding it may affect the performance margin and the energy coupling between the primary and the secondary.

Though the non-nuclear components can be tested easily for deterioration, the nuclear package can be tested only by underground explosive tests. Since most countries have stopped explosive tests, they have adopted different approaches to ensure reliability of the arsenal without nuclear testing. One such adopted by the United States is known as the Stockpile Stewardship Program. It is based on a strategy of surveillance, assessment and refurbishment.

The United States has more than 5200 active nuclear warheads belonging to a dozen types. Each year the engineers systematically inspect some twenty samples of each type. The inspection includes destructive testing of non-nuclear components such as chemical explosives and non-destructive testing of other components where they look for signs of aging like cracks, warps and corrosion. They also use supercomputer simulations to assess the possible impact of any such deterioration on the weapon's safety and reliability.

Though the weapon experts have observed certain number of age-related defects, they are of the opinion that many of them are not serious enough to compromise the reliability of the weapon itself. In this fashion, they have been able to certify each year, for the past two decades, the reliability of the country's nuclear arsenal. Other long-standing nuclear weapon countries have similar programs.

Accelerated Aging

Along with this, a variety of studies have been conducted to understand the process of aging using plutonium from dismantled weapons. These include X-ray absorption fine structure analyses to study its crystalline structure, high-resolution transmission electron microscopy to observe the evolution of microstructures and accumulation of helium, and so on. Surprisingly, these experiments have revealed that majority of the defects caused by self-irradiation are annealed in due course and the plutonium samples approach ideal crystalline structure with aging. This suggests that plutonium may stay stable for several thousands of years.

However, plutonium is the most highly unpredictable of all the metals and some aging may appear suddenly after years of stable behavior. Hence, scientists are carrying out laboratory experiments to accelerate the plutonium aging process to predict its performance on a long-term basis.

Weapon grade plutonium is the isotope Plutonium-239 (Pu-239) with a half-life of about 24,000 years, which means it decays too slowly for studying long-term effects. The trick is to spike the weapon plutonium with another isotope, Plutonium-238, which decays 300 times faster. If Pu-239 were spiked with 7.5 per cent of Pu-238, it would age about 16 times faster than weapon plutonium.

After six years in to the experiment, which is equivalent of 60 to 90 years of aging, scientists at the Los Alamos Scientific Laboratory in USA found slight increase in volume, decrease in density and increase in strength of the plutonium alloy. Based on these results they are of the view that the plutonium pits may have credible lifetime of at least 85 years. However, because of the peculiar properties of plutonium and its strategic importance, the experiments on aging continue to discern the long-term effects of helium accumulation on its properties.

The results of such experiments will be very crucial in deciding how long to rely on the existing stockpile, when to go for newer ones and determine the fate of treaties like Comprehensive Test Ban Treaty and Fissile Material Cut-off Treaty.

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In spite of being one of the world's largest food producers, India has the highest number of malnourished people in the world, accounting for one third of 2 billion people worldwide suffering from these deficits. The need of the hour is to work towards supplementing the Indian diet with adequate micronutrients in an affordable way to achieve health and prosperity for all.

"World peace will not be built on empty stomachs and human misery. Deny farmers modern technology and the world will be doomed, not from environmental degradation as some would like us to believe but from starvation and social and political chaos."

—Eminent agronomist and Nobel laureate Dr Norman Borlaug

Harnessing Hidden Hunger

SHARMISTHA BAR THAKUR

REPORTS of a looming global food crisis and high food prices have brought India also into the ring albeit this time the other way round, courtesy improved diet of Indians. The hunger in the country may have been reined in but we are still grappling with providing adequate nourishment for all. There is a huge difference between hunger (caloric intake of less than 2100 Kcal) and malnutrition (lack of essential nutrients).

A sufficient and balanced diet is the most important contribution to human health and well being. A balanced diet should supply not only energy but also essential amino acids, particularly the uncommon sulphur-rich amino acids, lysine, methionine, vitamins, folic acid, and the ionic elements iodine, iron, zinc and selenium. Chronic deficiency of these nutrients can lead to severe symptoms, including developmental disturbances of the fetus, restrictions of cognitive perception in children, lethargy, blindness and acute immunological malfunctions. Since these symptoms are not obviously associated with an inadequate diet, this malnutrition is also termed *'hidden hunger'*. Consequently, malnutrition is a major problem specifically in developing countries where a diversified diet is not affordable to the majority.

Deficiencies in micronutrients (iron, iodine, selenium, zinc, vitamin A, E, folic acid, etc.) afflict over 3 billion people worldwide, which is over half the world's population, most of them women, infants, and children in resource-poor families in the developing world. It is associated with half of all deaths in children under the age of five every year. In developing nations, 146 million children under five are underweight and 60 million are wasted (low weight for height). It has been estimated by the World Health Organization that about 2

Although conventional breeding still has the potential to increase micronutrients in crop plants, biotechnology offers a high potential in the field of biofortification.

India has the highest number of malnourished people in the world

The hunger in the country may have been reined in but we are still grappling with providing adequate nourishment for all

Golden rice could help combat vitamin A deficiency

billion of the world population, primarily women and children, suffer from iron malnutrition, while about 2.8 million children suffer from severe symptoms of vitamin A deficiency.

Ironically, in spite of being one of the world's largest food producers India has the highest number of malnourished people in the world, accounting for one third of 2 billion people worldwide suffering from these deficits. Less than 50% of micronutrient RDA is consumed by over 70% of the population causing 1% loss in the GDP amounting to Rs 27,720 crores per annum in terms of productivity, illness, increased health care costs and eventually death.

Several strategies have been pursued to defeat micronutrient malnutrition worldwide, notably through fortification of food, disease reduction, pharmaceutical preparation, dietary diversification and currently through biofortification—a method that improves the content of vitamins and minerals directly in the crop plant. Enhanced nutrition is also being promoted through functional foods and nutraceuticals—foods fortified with added, concentrated or biotechnologically introduced ingredients to a functional level to improve health.

Genetically improved plants can reach rural areas and represent a sustainable system, with very low recurrent costs.

Agricultural technology has achieved major successes in increasing and securing output as well as improving product quality. Till sometime ago, emphasis of breeders was on increasing macronutrients and yield. Today agriculture strives towards improving food quality, micronutrient composition and functional ingredients. The success of plant biotechnology is allowing targeted improvement of food crops for better agronomic performance as well as nutrient composition.

Breeding for accumulation of micronutrients is often difficult. However, with recent developments, transgenic technology is fast emerging as a supplementary technique to plant breeding and could contribute significantly to enhance these traits in the future. Some of the recent examples of biofortified food in various stages of development worldwide using biotechnological interventions are discussed below. The need of the hour is to work towards supplementing the Indian diet with adequate micronutrients in an affordable way to achieve health and prosperity for all in the true sense—the right to food.

Vitamin A: A breakthrough in genetically modified food was achieved with 'Golden Rice' (GR), which is a variety of rice genetically engineered to produce β carotene (pro-vitamin A) by using genes from Daffodil plant and bacteria to help combat vitamin A deficiency. However, the β carotene content of GR1 was not sufficient to deal with Vitamin A deficit. The RDA for Vitamin A is 300 μg for 1-3 yr old children. It had been predicted that GR's contribution to alleviating vitamin A deficiency could be substantially improved through even higher β-carotene content.

The daffodil gene encoding phytoene synthase (*psy*), one of the genes used to develop Golden Rice, was the limiting step in β-carotene accumulation. Through systematic testing of other plant *psy*'s, a *psy* from maize was identified that substantially increased carotenoid accumulation in a model plant system. 'Golden Rice 2' was developed introducing this *psy* in combination with the bacterial *Erwinia uredovora* carotene desaturase (crtl) gene used to generate the original Golden Rice 1. An increase in total carotenoids of up to 23-fold (maximum 37μg/g) compared to the original Golden Rice and a preferential accumulation of β-carotene was observed. Very recently metabolic engineering of potato tuber carotenoids through tuber-specific silencing of another gene lycopene epsilon cyclase has also been achieved.

Vitamin E: Tocopherols are the primary form of vitamin E in seeds of most cereals including rice and wheat.

HarvestPlus
Breeding Crops for Better Nutrition
Children must have micronutrients to be healthy. Find out why.
Read more
Grand Challenges in Global Health

Harvest Plus is a global alliance of research institutions and implementing agencies that have come together to breed and disseminate crops for better nutrition (left);
The Grand Challenges in Global Health initiative is a major effort to support micronutrient biofortification of staple crops (below)

The potential of One Golden Rice seed

1 seed >1 plant> 1000 seeds or 20g; >1000 000 seeds or 20kg;
>1000 000 000 seeds or 20t; 1 000 000 000 000 seeds or 20t;
> 1000 000 000 000 seeds or 20 000t.

In 2 years one seed can grow to 20 000 tons of rice!

All a farmer needs to benefit from the technology, is one seed.

Each seed has the potential to produce in 2 years food for 100 000 poor and for one complete year.
And it includes the technology to reduce vitamin & malnutrition in a sustained and cost-effective manner.

Extreme precautionary GMO regulation prevents the farmers from using this potential.

As a potent antioxidant, Vitamin E contributes to the nutritive value of cereal grains in human and livestock diets. Gene encoding homogentisic acid geranylgeranyl transferase, which catalyzes the committed step of Vitamin E biosynthesis, was isolated from barley, wheat and rice seeds. Transgenic expression of this barley gene in model plant *Arabidopsis thaliana* leaves resulted in accumulation of 10-15-fold increase in total vitamin E antioxidants, which was absent from leaves of nontransformed plants. Over-expression of this gene in corn seeds has also resulted in a six-fold increase.

Folates: Folates are essential cofactors in most living organisms and are required for the biosynthesis of nucleic acids, amino acids and pantotheonate. Unlike plants and microorganisms, humans cannot synthesize folates *de novo* and must acquire them from the diet, primarily from plant foods. However, lack of folates is the most common vitamin deficiency in the world and consequently there is much interest in engineering plants with enhanced folate content. By introducing a gene of the folate biosynthetic pathway from bacteria, GTP cyclohydrolase-1, into *Arabidopsis thaliana*, a two to four fold enhancement of folates has been observed. The work has opened up avenues for identifying other potential factors regulating folate synthesis; suggesting ways to further enhance folate levels in food crops.

Minerals: Transgenic research for improvement of micronutrient content and availability in crops focuses mostly on the two most common mineral deficiencies, iron and zinc. The first barrier to micronutrient absorption resides in the root-soil interface. To overcome iron shortage, plants have developed different response mechanisms to increase iron solubility and to allow iron uptake from the rhizosphere. Plant roots can access iron by two different strategies: strategy I, used by all dicotyledonous plants and nongraminaceous monocots, and strategy II, which characterizes the graminaceous monocots.

In iron-deficient soil, Strategy I plants induce an increase of iron reduction, transport and release, whereas Strategy II plants rely on the secretion of low molecular weight compounds called phytosiderophores. Once absorbed, micronutrients need to be efficiently translocated and accumulated in the edible part of the plant in a non-toxic form making them bioavailable upon digestion.

Ferric reductase and ferric chealate reductase genes have been used to produce transgenic plants.

Wheat field (extreme left)
Transgenic expression of barley gene in *Arabidopsis thaliana* resulted in accumulation of 10-15-fold increase in total vitamin E content (left)

A balanced diet should supply not only energy but also essential amino acids, particularly the uncommon sulphur-rich amino acids, lysine, methionine, vitamins, folic acid, and the ionic elements iodine, iron, zinc and selenium.

Steps in the nutritional breeding pathway: A) Germplasm screening; B) Advanced line evaluation; C) Plant breeding.

Nicotinamide aminotransferase, a gene in the biosynthetic pathway of phytosiderophores, has been put into rice which has shown a better resistance to iron chlorosis in calcareous soils. Amplification of the natural iron stores ferritin in seeds and over-expression of a zinc transporter has shown a modest increase of iron content in seeds. By reducing antineutrients such as phytic acid the bioavailability of iron can also be increased.

An alternative strategy for bioavailability improvement is to increase the levels of promoter compounds. Cysteine is the only free amino acid with an enhancing effect on iron absorption in humans. A better iron availability is expected by increasing the amount of cysteine residues in crop plants by over-expressing a group of cysteine-rich, low molecular weight polypeptides, metallothionein proteins.

Harvest Plus, an initiative of the Consultative Group on International Agricultural Research (CGIAR) is a global alliance of research institutions and implementing agencies that have come together to breed and disseminate crops for better nutrition. It is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). Initial biofortification efforts are focusing on six staple crops for which prebreeding feasibility studies have been completed. These are beans, cassava, maize, rice, sweet potatoes, and wheat. The program will focus on the potential for nutrient enhancement in 10 additional crops viz banana, barley, cowpea, groundnut, lentil, millet, pigeon pea, potato, sorghum, and yam.

The Grand Challenges in Global Health initiative is another major effort to achieve scientific breakthroughs against diseases that kill millions of people each year in the world's poorest countries. Announced by the Bill and Melinda Gates Foundation on 28 June 2005, it has offered grants totaling $436.6 million for a broad range of innovative research projects. Included amongst the various challenges is challenge number four to support micronutrient biofortification of staple crops for use in developing countries worth US$30 million over five years. It includes four projects covering pro vitamin A, vitamin E, Fe, Zn and high protein content.

Genetically improved plants can reach rural areas and represent a sustainable system, with very low recurrent costs. Micronutrient-dense cereal varieties have the added benefit of improved resistance to diseases and environmental stresses, and they are particularly efficient in trace mineral-deficient soils and arid regions. Furthermore, these varieties are largely independent of soil types and climate.

Although conventional breeding still has the potential to increase micronutrients in crop plants, biotechnology offers a high potential in the field of biofortification. It could particularly overcome the limitations of endogenous regulation of vitamins or mineral levels and has already shown promising results. Still the field is in its infancy and increasing knowledge about functional genomics will further increase the potential of biotechnology as a supplement to breeding for biofortification.

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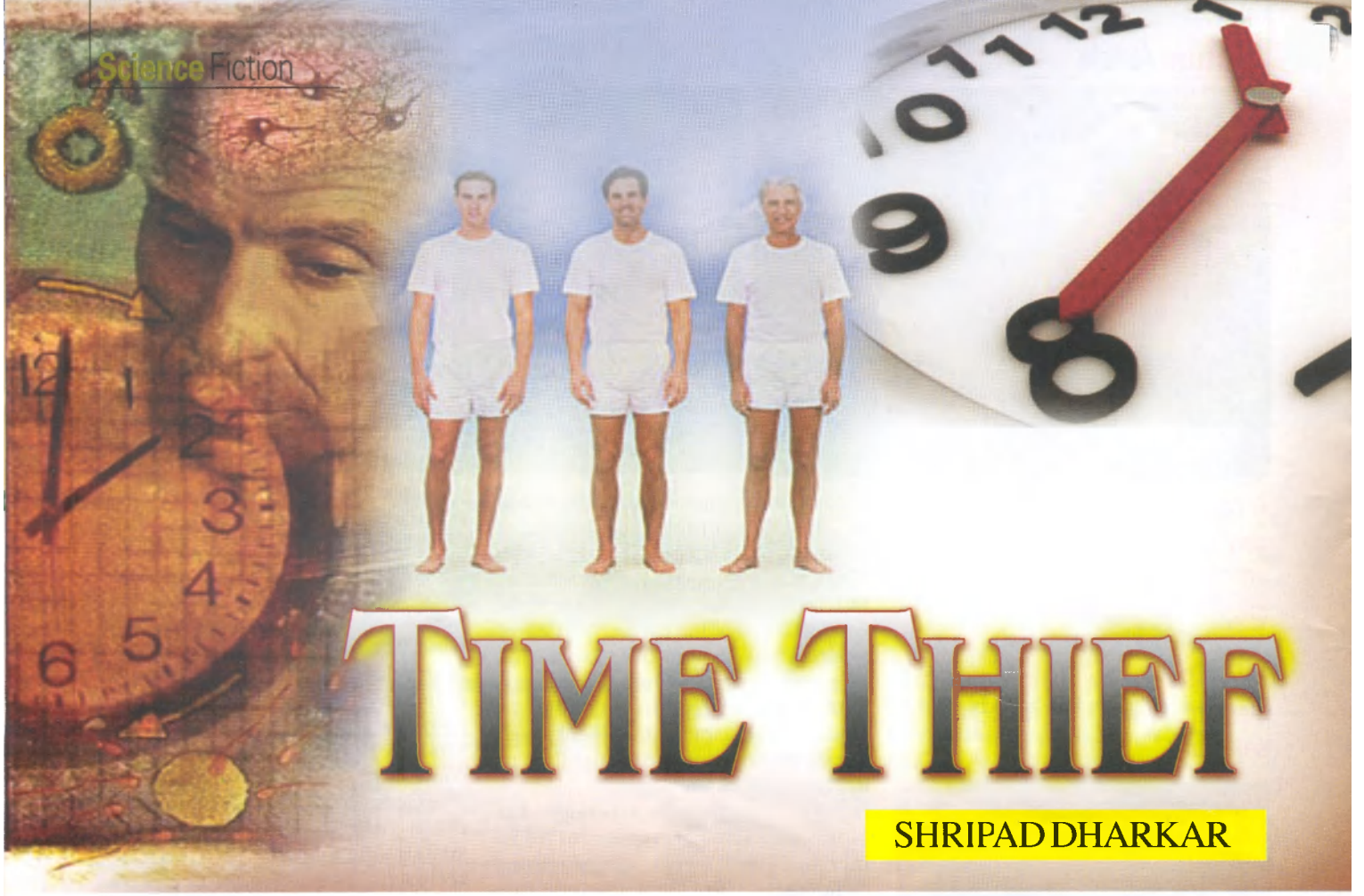

TIME THIEF

SHRIPAD DHARKAR

THERE was a hoarse cry from the man as he slumped helplessly on a chair. It seemed as if he had lost all his energy. Inspector Rane was looking at him with unbelieving eyes. Slowly and slowly the man was changing. His beautiful hair was falling about him, balding him. The hair on his nape was graying. His eyes, going inside their sockets were getting smaller and smaller. Wrinkles on his forehead, cheeks shrunk. His well-built body receded – his clothes hanging loose. He looked like a man more than fifty.

"Why, you look old! What happened to you all of a sudden!" cried his wife.

Inspector Rane was looking at him astounded, as if he were seeing a horror film. Humans attain old age slowly over many years in a dignified way, but getting old all of a sudden – in a matter of minutes – and that too old by twenty years in such an unbelievably short time was a most unlikely happening. But it was all happening before him!

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The party was arranged on the third floor terrace of Mr. Pawar's residence. Inspector Rane was rather surprised on being introduced to Dr. Vishwas, his wife and daughter, for the wife looked fiftyish, the daughter about twenty-five but the doctor himself not a day beyond thirty. The old woman had married again after the death of her first husband, thought Rane, a vigorous handsome fellow of thirty.

"Dr. Vishwas, are you a medical practitioner?" asked Rane.

'No, no. Nothing trivial like that," answered the doctor, vanity oozing from every word. "I have a doctorate in Physics from M.I.T., from the United States. I have my own laboratory here."

"Oh, quite great," exclaimed Rane, impressed.

"And you, what is the great detective doing in this small town. Our host Pawar told me about you," said the doctor with a sniggering grin.

"Well, Sir, we policemen have to go wherever our friends the criminals are entrenched. We have information that narcotic smugglers are operating in a big way, taking advantage of the seacoast. Moreover there are gang wars. That's why I have been transferred here," answered Rane in his consummate modest manner. "You must have read about the gang wars in newspapers."

"I don't have time to read these rotten newspapers. I am knee-deep in my own work," Vishwas rubbished Rane.

****

"Well, Karnik, where do we look for your friends – the druggists?" asked Rane humorously to his assistant.

"Sir, in fact they are your friends. You came here specially to meet them," Inspector Karnik bantered back.

"That's a good one, Karnik," laughed Rane, "...but I would like to see Morya, our mole smuggled into their web."

This serum, will wipe out your memory completely..... You will wander the streets asking everybody your own name .....

"Welcome Morya," said Rane on Morya's arrival. "Sit down comfortably and tell me the news. Who are purchasing these narcotics and how much. Have you made a list of all these people?"

"Yes Sir, you will be surprised. There are quite a few, their names and addresses are here."

"Hmmm...," mused Rane as he glanced over the list. "One gram, two grams and their buyers. Quite a long list."

"Yes, Sir. But, Sir, I am going to give you a jolt. There is someone buying big. A big buyer and a big man to boot."

"Yeah, you are talking like a big detective. Karnik, Sherlock Holmes has come to town," Rane laughed. "Morya, tell me who is this big buyer and a big man to boot'.

"His name is Dr. Vishwas".

****

"It is unlikely but if Morya is telling the truth..." Rane mulled over this unlikely scoop, as they meandered near Vishwas's bungalow. It seemed to be built on quite large proportions. A garden placed decorously in the front gave it an even bigger appearance. It was a ground plus first floor affair. The first floor seemed to be made of two or three bedrooms from the number of windows screened by well-designed curtains. The ground floor had no windows, excepting the kitchen. From the overall appearance the windowless area seemed quite big, but surprise of all, the terrace seemed to be covered with a massive something; a huge treelike structure with its branches like spears pointing in all directions.

"Karnik, did you see the treelike structure on top? Seems it is made of crystals, as light is passing through it. Something odd, like its oddball master. Something mystifying and incomprehensible."

"Yes, you said it, Sir," agreed Karnik.

"Karnik," said Rane, "We have to keep tabs on this fellow. When he is not there we should go see his wife. She seems to be an honest and simple lady."

"What are we waiting for then? The doctor has gone to Mumbai. The lady is alone in the house."

"Let's go then," said Rane.

When they rang the bell, Mrs Vishwas herself opened the door and was taken aback. It was not usual to see policemen knocking at her door.

"We are sorry to trouble you," said Rane, "but robberies are taking place in this locality. We came here to warn you. See that all doors are locked and bolted."

"Thank you, Inspector. It is nice of you to warn me. But, won't you come in? I shall have tea made for you."

As they sat in the well-furnished hall, Rane had a close look at the picture on the mantelpiece. It was of the daughter of the house.

"Your daughter looks exactly like Dr. Vishwas. Doesn't she, Karnik?" exclaimed Rane.

"Well, after all he is her father. She has taken after him. They say girls take after their fathers and boys after their mothers," answered Mrs. Vishwas.

Rane and Karnik had a quick surprised glance at each other, which did not go unnoticed by Mrs. Vishwas. So she continued.

"You know, Vishwas and myself were studying together in Ferguson College. We were all the time together and decided to get married. He is actually my age but looks much younger." Then laughing she said, "People are intrigued. They wonder whether I have married a much younger man. Isn't it funny?"

Rane just smiled. "Some people grow slowly," he said.

"Yes, but rather too slowly for my liking."

"What is he working on?" asked Rane casually.

"God knows! I am just an ordinary woman looking after the house. But I am glad he has stopped working with those horrid rats. Those days the whole house reeked with their smell."

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"Quite a character, this doctor," observed Karnik, as they entered their office.

"Hmmm," mused Rane, "everything is getting curiouser and curiouser. First the treelike structure on the terrace, then the big windowless area, like a godown, third his young appearance, then the experiments with rats. I wonder if he is developing some drug to remain young. Karnik, I think if we introduce a bug in his laboratory, we can hear what is going on."

"Yes, boss, it's easy as a pie."

After this Karnik entered the laboratory, through the back door and placed the bug in a corner. The bug was like a small ball, the size of a lemon and had the capacity of relaying all the sounds from the lab to sophisticated equipment in Rane's office.

"Vishwas," a woman's voice coming through the bug. "What experiments are you doing? The police had come here on some pretext."

"What!" a man's voice. "What do they want here? In this gentleman's house – the swines!"

"They were rather taken aback when I told them you are my age."

"Ha," a voice vain and proud, "they will never know how I manage to remain thirty. Nobody will know the prowess of this greatest scientist in the whole world. My research will bring me the Nobel prize when I publish even a single page dissertation in *Nature*. But beat it, I have work to do!"

"Yes, I am going. But I always wonder about this big eight-foot grandfather clock and this helmet attached to it by wires. Has it something to do with your age?"

'Ha, go away woman, I have lots to do."

****

"Karnik," said Rane in his musing thoughtful voice. "What is this lady speaking about—the grandfather clock and the helmet attached to it by wires? Then she asks whether it has something to do with his young age. We have seen that treelike crystalline structure on the terrace and wires going down to the godown. In all probability the wires would be connected to the grandfather clock, which is attached to the helmet. Let us visualize; he wears the helmet and then....does something to the clock...and bingo, something happens...but what?"

As he was speaking, he glanced at his wristwatch. It showed first of that month and 12 o'clock at night. But as he was looking at it, the watch jumped

We have information that narcotic smugglers are operating in a big way, taking advantage of....

by five minutes. It then showed 5 past 12.

"What is happening? My watch jumped five minutes all of a sudden!"

"So has mine," said Karnik surprised, "and all the clocks in this office. All showing 5 past 12."

"Most uncanny! As if someone has stolen 5 minutes from our lives all of a sudden, eh, Karnik?"

"What an idea!" exclaimed Karnik. "Only you can think like this." And both laughed.

Next day, Rane entered Vishwas' lab by picking the big lock on the back door. His first impression was of the odd smell, a melange of chemicals and narcotics. He browsed everywhere and came to a layer of bags with some powdery stuff. He smelled.

"So Morya was right. The great scientist is really buying narcotics."

On other tables was lying a surfeit of chemical equipment. But what attracted him the most was the eight-foot high grandfather clock. Wires were attached to it, obviously coming from the crystal tree on the top. From the other side of the clock other sets of wires were attached to a helmet-like object, neatly kept on a small table.

As he was absorbed in these odd things, a terrible blow fell on his head from behind. He fell unconscious, how long he did not know, but when he came out of his torpor, he found water trickling down his head. He heard a woman's voice.

"What are you doing, Vishwas? You knocked down the poor man and tied him to this chair."

"He had no business interfering in someone else's property, he has paid for this sacrilege from which there is no redemption." Then turning towards Rane he bantered, "How are you feeling now my dear Inspector Rane? If you wanted to know something about me I would have told you. Then why this breaking in like a thief? Probably you are rather inquisitive about my youthful looks, is it?"

"Well, there is nothing criminal about looking young. You would never be hauled up before a court for this," answered Rane in spite of an aching head.

"That's better! Do you see that big clock? It is not an ordinary clock. It is something special made by me after years of patient research. That, and the hat-like object. I wear it and put the clock forward by just five minutes. What happens afterwards will make your imagination wobble. Five minutes from the lives of each person staying in this town are drawn through the treelike antenna on the terrace and go into my head and I become younger by a month. So one month spent and one month gained. This I am doing for the last twenty years. That's why I am thirty years old all the time. You would marvel at this phenomenon!"

"Yes, my imagination wobbles, as you rightly said. But you have stolen lives from innocent people without their consent. I cannot arrest you for this. There is no provision in the law – for this is new and something staggering. But I wonder what you are doing with the narcotics stacked over there?"

"Ho, ho, ho...," laughed the mad scientist. "Thanks, thanks for reminding me. I was forgetting it altogether."

He opened a cupboard and took out a vial of some chemical and a syringe.

"My dear Inspector, I have told you enough but I don't want it to go out of this laboratory. This serum, made from what you call the banned drugs will cure you, as it will wipe out your memory completely. You will wander the streets asking everybody your own name, your address, your vocation. You will be like a beggar. Your department will also disown you. You are doomed – a punishment for entering this laboratory."

He took the chemical in the syringe and proceeded to inject the dreadful serum into Rane's forearm, but a blow from a stick smashed the syringe from the mad scientist's hand.

"You bitch," he roared, "you have ruined my precious work. You will pay for this."

Like a madman, his eyes wild, teeth bared, he caught hold of his wife. "I shall strangle you to death for this." With that he started to choke his wife.

Inspector Rane could not witness this inhuman act. He stood up with the chair roped to his back. He swung himself around and hit Vishwas with the chair. Vishwas got madder. He pounced on Rane but Rane again swung hard with all his strength. The mad scientist was thrown hard towards his precious clock. The clock tottered wildly and oscillated, about to fall. Vishwas tried his best to keep it upright, but it was too heavy for him and it swayed and fell with a shattering bang!

All the cogs, wheels, nuts and bolts got strewn on the floor - the end of a madman's dreams! The treelike antenna on the terrace flashed and exploded. The dial of the clock was looking at Rane like a dying man. It started whirling round and round, backwards, backwards, backwards. There was a hoarse cry from Vishwas, who slumped on a chair, all energy lost.

Rane's bonds were cut off by Mrs. Vishwas, so he was free by then. He was staring at the man slumped on the chair—slowly, Vishwas was changing. His eyes were retreating inside his sockets, getting smaller. Wrinkles on his forehead, cheeks shrunk; his well-built body receded, his clothes hanging loose. He looked like a man more than fifty.

Mrs. Vishwas was crying, "What has happened to you Vishwas? How are you looking so old all of a sudden? Oh, God, what am I supposed to do now?"

After the initial shock was over, Rane could find words.

"Don't worry Mrs. Vishwas. Admit him in a good nursing home and he will be all right in a few days. As for robbing years of life from other people no court will believe this wayward maverick happening, so we can forget it. About the narcotics stacked in his laboratory and the attempt to destroy me, I think Vishwas has paid enough, as you can see for yourself. So, I am not going to press any charges. You can also pardon him for his excesses and nurse him back to health. Live with him happily. I bid you goodbye and good luck."

Dr S.D. Dharkar, 113, D'Souza Colony, Next to Tennis Club, Nashik-422 005

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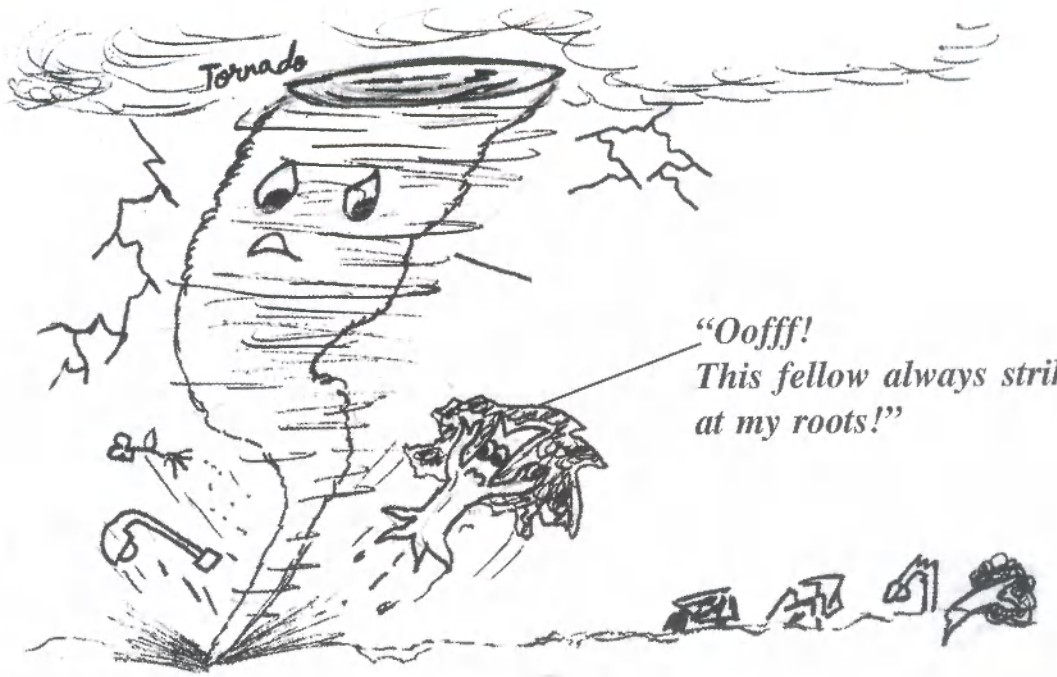
Smallest Micro Chip Invented

"There goes my record of being the smallest worker."



Malicious *Malaria*

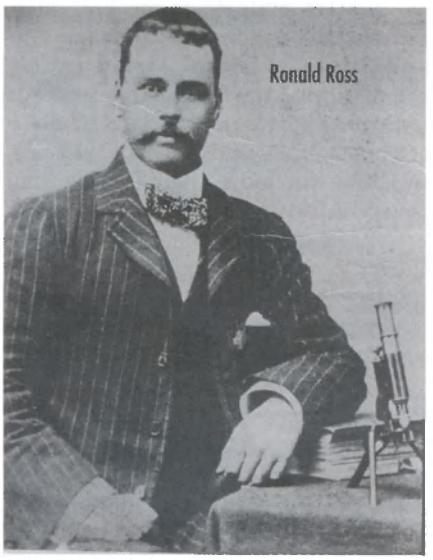
The challenge is to develop a safe and effective malaria vaccine but till then save yourselves from a mosquito bite and take timely treatment if malaria is detected.

P. CHEENA CHAWLA

COME summer and then rains, the terror unleashed by mosquitoes gets into full gear. The aftermath of a scratchy, painful bite of a mosquito could be traumatic, if the biting insect harbors the highly infective forms of a deadly bug called *Plasmodium* — the malarial parasite. So much so, if left untreated, there may occur severe life-threatening complications that often kill the victim.

This happens in most tropical regions of the world particularly Asia, Africa, Central and South America, where malaria is rampant and people are brutally exposed to the compromised health conditions. On a worldwide scale more than 250 million cases of malaria occur every year, out of which about a million victims die — mostly young children in sub-Saharan Africa.

The term 'malaria' has its roots in the words *mal* and *aria* that mean 'bad air' in Italian. Known since antiquity, malaria can be caused by four different species of *Plasmodium*, the most deadly being *Plasmodium falciparum*. The other three species are: *P. vivax*, *P. malariae*, and *P. ovale* that generally do not cause life-threatening disease. A fifth species, *Plasmodium knowlesi*, causes malaria in monkeys but can also infect humans.


Ronald Ross

It was in 1880 that Charles Laveran, a French army doctor working in the military hospital of Constantine in Algeria first identified the malarial parasites in human blood. He was awarded the 1907 Nobel Prize for Physiology or Medicine. In 1889, Sir Ronald Ross discovered that malaria was transmitted in human beings through mosquitoes. For this work Ross received the 1902 Nobel Prize in Physiology or Medicine.

The Life Cycle

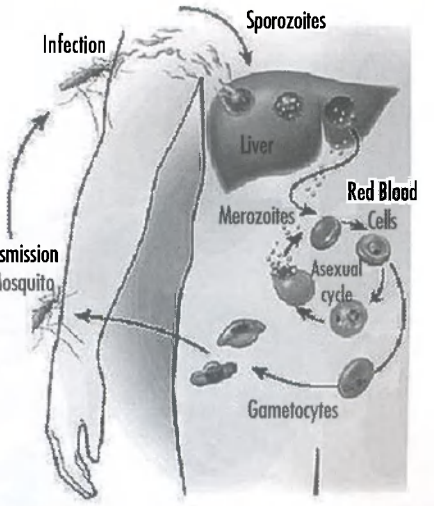
Nature has bestowed the malarial parasite a complicated life cycle that involves two hosts. Female mosquitoes of the *Anopheles* genus are the primary host, while human beings are the secondary hosts. The disease raises its ugly head in human beings when an infected *Anopheles* mosquito bites a person and injects the infective stage of malarial parasites called 'sporozoites' into the blood stream.

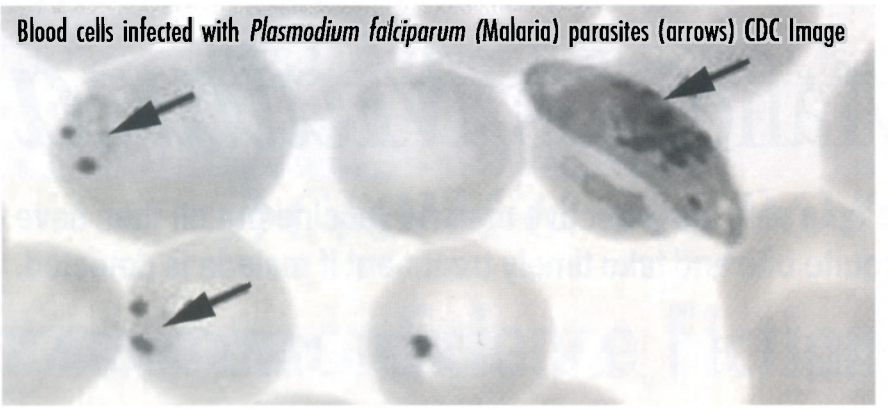
The parasites then embark upon their vicious journey to destroy the liver and blood cells of the host. This normally takes about one to three weeks from the day of the mosquito bite. The symptoms of illness start to appear in the victim only after this incubation period, which is quite variable and depends on the species of the infecting parasite as well as the health status of the victim prior to infection.

The vigorously moving sporozoites, while traveling through the bloodstream, soon find their way to the liver, where they undergo maturation and multiply into merozoites. As their numbers increase, they rupture the liver cells and escape back into the bloodstream. The bug finally wages a war on the human red blood cells (RBCs), where they develop into ring forms, and later form trophozoites, schizonts and then back into merozoites. The 'exoerythrocytic' phase of malaria infection in the human host involves infection of liver, while the 'erythrocytic' phase involves infection of the RBCs.

The characteristic waves of fever and chills in malaria occur as merozoites are released from liver cells that go on to infect the RBCs. Once inside the RBCs, the malarial parasite grows and reproduces to form many of its kind until a mosquito feeds on this infected human host while taking

LIFE CYCLE OF MALARIA PARASITE





Blood cells infected with *Plasmodium falciparum* (Malaria) parasites (arrows) CDC Image

a blood meal and ingests the RBCs that contain the parasites.

The ingested malarial parasite, in the form of gametocytes, reaches the stomach of the *Anopheles* mosquito. These gametocytes then differentiate into male or female gametes, which then fuse in the mosquito gut. The resultant, an ookinete, penetrates the gut lining and produces an oocyst in the gut wall. This oocyst ruptures and finally releases the infective forms of malaria parasite called sporozoites that migrate through the mosquito's body to the salivary glands. The infected moquito is now ready to infect a new human host. The parasite's cycle is completed once an infected *Anopheles* mosquito bites a human host and transfers the sporozoites to the bloodstream.

Striking Symptoms

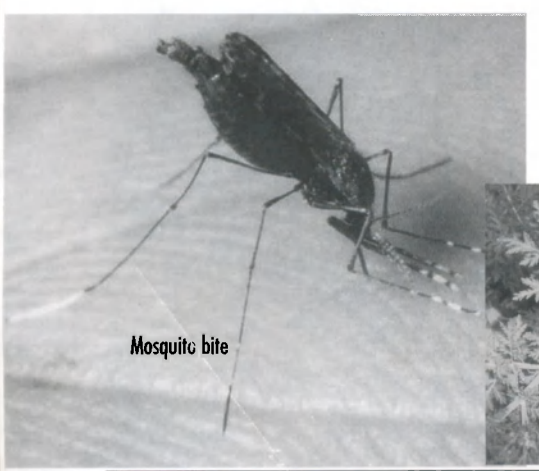
The cyclical occurrence of sudden chills followed by fever and sweating is repeated every two days in *P. vivax* and *P. ovale* infections, while it occurs every three days for *P. malariae*. *P. falciparum* can have recurrent fever every 36–48 hours or an almost continuous fever. A bout of malaria may also typically cause yellowing of the skin and whites of the eyes due to destruction of RBCs and liver cells. Besides causing severe anemia, malaria cause cognitive impairment due to brain damage especially in children.

The worse hit are victims of *P. falciparum* infection or cerebral malaria as they might develop bleeding problems, liver or kidney failure, seizures and even coma. This lethal assault by the malarial parasite kills the victim in most cases. Chronic malaria normally occurs in *P. vivax* and *P. ovale* infections, where the disease can relapse months or years after exposure, due to the presence of latent parasites in the liver.

Diagnosing Malaria

The conventional tool to diagnose malaria is the detection of the malarial parasite inside the RBCs from the blood smear of the person taken on a glass slide and stained with Giemsa stain. Although a simple test, the correctness of results of this test largely depends on the skill of the technician who examines the slides under the microscope.

Other tests like polymerase chain reaction (PCR) test and rapid diagnostic test based on malaria antigen detection are more expensive and not available widely. Rapid diagnostic tests have been developed for *P. falciparum* antigens, namely, glutamate dehydrogenase and lactate dehydrogenase.



Mosquito bite

Artemisia annua is used in China to cure Malaria

Treating Malaria

The treatment for malaria depends on the infecting species of *Plasmodium* parasite. Also important is the victim's health status. Malaria infection during pregnancy seriously threatens the life of the unborn child. Besides, drug susceptibility of the infecting parasites largely varies, as species of *Plasmodium* found in specific parts of the world are known to be resistant to certain medications.

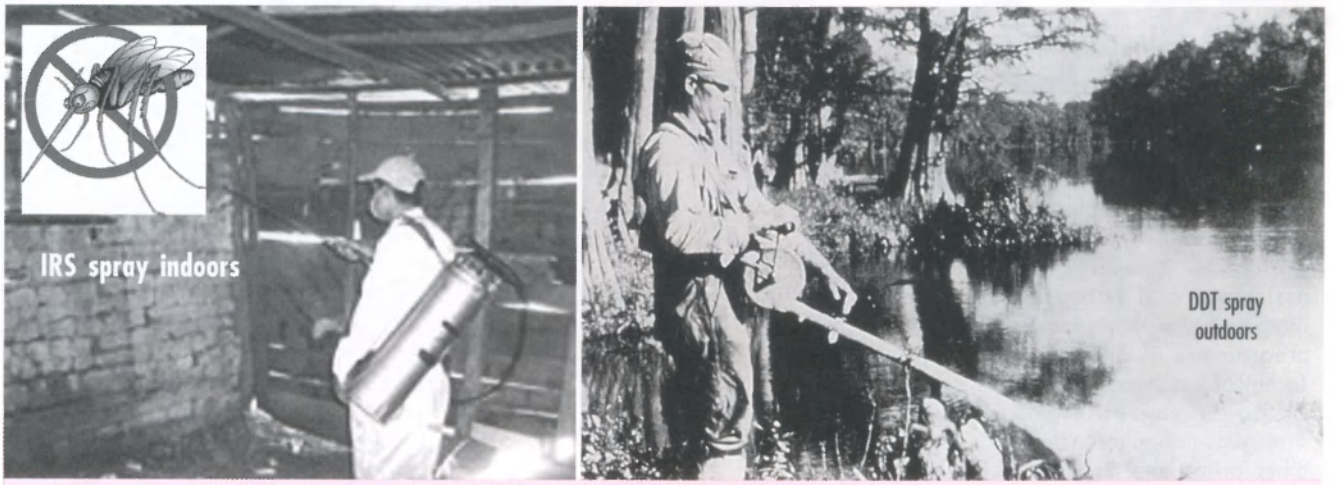
The first effective treatment for malaria came from the bark of cinchona tree, which contains quinine. This tree normally grows on the slopes of the Andes in Peru. Quinine has been used as a potent drug against malaria since the 17th century. Chloroquine phosphate is the drug of choice for all malarial parasites except chloroquine-resistant *Plasmodium* strains. *P. falciparum* and *P. vivax* have been reported resistant to chloroquine.

Drug resistance in malarial parasites occurs due to non-adherence to the treatment schedule, which is why multiple drug-treatment therapy is employed to kill the drug resistant *Plasmodium* strains. For example, *P. falciparum* acquired in the Middle East countries is usually susceptible to chloroquine, but if acquired in sub-Sahara African countries, is usually resistant to chloroquine. Some effective alternatives of quinine are quinacrine, chloroquine, and primaquine. Other drugs being used to control and treat malaria include mefloquine, doxycycline and a combination of atovaquone and proguanil hydrochloride.

Severe malaria is treated with intravenous or intramuscular quinine and also a herbal drug called artemisinin. Artemisinin, an extract from sweet wormwood (*Artemisia annua*) has been used as herbal medicine in China for more than 1,000 years. Several African countries have adopted artemisinin-based combination therapy (ACT) as the first-line treatment for *Plasmodium falciparum* malaria and use of quinine as second-line therapy.

Preventing Malaria

The common precautions one needs to take for preventing malaria in mosquito-infested areas include the wearing of appropriate clothing to



Indoor residual spraying effectively kills the mosquitos resting on the walls after a blood meal. This is an effective method to control the spread of the malarial parasite to other healthy individuals.

avoid mosquito bite, using insect-repellant creams on skin and spraying of insecticides to kill the mosquitoes, besides using mosquito bed nets and draining stagnant water where mosquitoes lay their eggs. It is also advisable to take specific anti-malarial drugs if one is traveling to malaria-risk areas.

The control of mosquito population along with treating the victims has helped in reducing the incidence of malaria in many parts of the world such as the United States and southern Europe. The use of DDT (dichlorodiphenyltrichloroethane) phenomenally reduced malaria in many parts of the globe. Another mosquito control method called the 'sterile insect technique' employs the biological control of insect populatons, whereby genetically modified species of *Anopheles* mosquito are created that are plasmodium-resistant.

Indoor residual spraying (IRS) is the practice of spraying insecticides on the interior walls of homes in malaria affected areas, which effectively kills the mosquitos resting on the walls after a blood meal. This is an effective method to control the spread of the malarial parasite to other healthy individuals. The first pesticide used for IRS was DDT. However excessive use of DDT for pest control resulted in the evolution of DDT-resistant mosquitoes, which is quite akin to antibiotic resistance in bacteria. Several other insecticides such as the pyrethroids, permethrin and deltamethrin are now used for indoor residual spraying.

Insecticide-treated nets (ITN) are mosquito nets impregnated with insecticides such as permethrin or deltamethrin. The use of such nets has been shown to be an extremely effective, low cost method of malaria prevention. In conjunction with distribution of mosquito nets, community education and awareness campaigns are pertinent in spreading the message for malaria prevention, particularly among the rural populace.

Malaria Vaccines

A major challenge before the scientific community today is to produce a safe and potent malaria vaccine. Unfortunately, the parasites remain well guarded from attack by the human defence machinery because they reside within the liver and blood cells. Any circulating infected blood cells are, however, destroyed in the spleen. To circumvent this, the *P. falciparum* parasite quite cleverly displays adhesive proteins on the surface of the infected blood cells, which causes the blood cells to stick to the walls of small blood vessels, thus avoiding them to enter the blood circulation. The blockage of these vessels results in many haemorrhagic complications typical of cerebral malaria. These adhesive proteins of *P. falciparum* cannot serve as antigen targets for designing malaria vaccine because these parasitic proteins exist in extremely diverse forms, especialy within parasite populations.

There is no completely effective malaria vaccine yet available, although several vaccine candidates are known and efforts are in full swing to develop a safe, potent and effective malaria vaccine. The first such effort was made in 1967 when mice were immunized with live, radiation-attenuated or weakened sporozoites. On injecting a challenge dose of viable sporozoites, about 60% of these mice were shown to be protected. Since then several efforts have been made to design vaccines based on irradiated sporozoites. The circumsporozoite protein (CSP) which coats the sporozoite has been considered as the target parasite antigen as antibodies against CSP prevent the sporozoite from invading liver cells.

Today there are several candidates for designing malaria vaccines. Pre-erythrocytic vaccines are those vaccines that specifically target the malarial parasite before it reaches the blood, which includes vaccines based on CSP. Other vaccine candidates include those that raise an immune response against the various blood stages of malarial parasite, and thus act as transmission-blocking vaccines. With the sequencing of *P. falciparum* genome, completed in 2002, new drugs and targets for vaccines are in the offing.

The first malaria vaccine that underwent field trials is the SPf66 developed by Manuel Elkin Patarroyo of Columbia in 1987. This vaccine was a combination of antigens from the sporozoite and merozoite forms of the malarial parasite. Although Phase I trials of this vaccine showed an efficacy of 75%, the later Phase II and III trials were not so promising, which is why this vaccine did not take to the market.

WHO Global Malaria Programme

As a part of WHO's global efforts to fight malaria, the Global Malaria Programme (GMP) envisages myriad activities that include malaria surveillance, monitoring and evaluation besides technical assistance and policy advice for integrating with national malaria programmes of different countries. Technical assistance at country level is also on diagnosis and treatment strategies, mosquito control including other preventive measures, besides supporting research for the development of new drugs and insecticides.

Another potential malaria vaccine candidate is RTS,S/AS02A, which has been developed by a partnership between the PATH Malaria Vaccine Initiative, GlaxoSmithKline, and the Walter Reed Army Institute of Research. This vaccine includes a portion of CSP that is fused to the immunogenic "S antigen" of the hepatitis B virus. The so-formed recombinant protein is injected with the AS02A adjuvant, for boosting the immune response. Although Phase I and II trials conducted in Mozambia have shown 62% reduction of infection with no serious side-effects in infants between the ages of 10 and 18 months, further studies are in progress before this vaccine finally hits the market perhaps in 2011.

In a significant development, Christopher V. Plowe, Professor of medicine at the University of Maryland School of Medicine along with a group of US and Belgian collaborators from the Walter Reed Army Institute of Research, USAID and GlaxoSmithKline Biologicals have developed a malaria vaccine that targets a molecule on the malaria parasite known as apical membrane antigen 1 (AMA1). This molecule sits on the surface of the merozoite form of the malarial parasite and helps it invade RBCs. On recognizing these AMA1 molecules, antibodies are produced by the human defence machinery that prevent invasion of RBCs by merozoites.

However, this protective response by the human body occurs only after repeated exposure to malarial parasite. Therefore, the idea is to develop a vaccine that activates the immune system to recognize AMA1 before malaria infection occurs. Plowe and his collaborators are now testing this new malaria vaccine for its safety and efficacy.

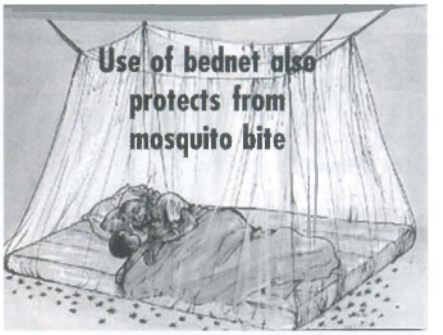
Efforts are also on to develop a vaccine against pregnancy-associated malaria (PAM). Occurrence of malaria in pregnant women is a serious health issue as the malarial parasite prevents the exchange of gases and nutrients through the placenta, leading to spontaneous abortions, premature deliveries and birth of low weight babies. New vaccines are being designed that block the binding of parasitized RBCs to the placenta.

In an exciting new development, Indian and American scientists have found a 'molecular switch' that controls mosquitoes' immunity to malaria-causing *Plasmodium* parasites. According to Sanjeev Kumar, who leads the Indian team at the Birla Institute of Technology (BITS) in Pilani, if the switch is on, then the mosquito has no immunity against malarial parasites and if it is off then the mosquitoes are immune to them. Kumar worked with a team at the US-based National Institutes of Health (NIH) to discover the switch.

Further, the scientists have discovered that when the blood meal is taken by a mosquito, it reaches the gut where it triggers two proteins: Immuno-Modulatory Peroxidase (IMPer) and dual oxidase (Duox). These proteins form a protective net-like bag around the blood meal that allows the malarial parasite to escape the mosquito's immune response. Therefore, on switching off the functioning of these two proteins, the malarial parasites get naturally killed in the mosquito body. New vaccines based on this finding are in the offing.

Genetic Resistance to Malaria

Certain diseases offer some protection against malaria. One such disease is sickle-cell anemia — a hereditary blood disease where a genetic alteration (mutation) occurs in the hemoglobin gene that encodes the beta-globin subunit of the hemoglobin molecule. In the merozoite stage when the malarial parasite lives inside RBCs, the infected cells tend to get deformed



and destroyed before the daughter parasites are formed due to the presence of a mixture of sickle and normal haemoglobin. Thus, victims of sickle-cell trait are fairly protected from getting a serious malaria infection.

It seems that the sickle-cell trait evolved in people living in malaria-endemic regions as the frequency of this genetic disorder is higher in such populations. Similarly, there are other mutations in the hemoglobin gene that produce altered versions of hemoglobin molecules, such as haemoglobin types HbE and HbC that confer some sort of resistance to malaria infection. These mutations are common in Southeast Asia and Western Africa respectively. Thalassaemia is yet another blood disorder that protects its victims from malarial infections. The altered gene in this disorder is also Nature's selection, as part of human evolution, in regions of the world where malaria is endemic.

Another example is the lack of surface proteins, called 'duffy antigens', on the RBCs of people inhabiting West and Central Africa where *P. vivax* infections are very common. Normally duffy antigens are specific receptor molecules present on the surface of RBCs, and the *P. vivax* uses this antigen to enter blood cells. This altered ability of expressing no duffy antigen on RBCs thus confers protection to *P. vivax* infection. An increased resistance to malaria is also conferred by high antibody levels against the antigens of malarial parasite, which is again naturally found in specific groups of people inhabiting malaria prone regions of the world.

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Aedes mosquito sucking blood

Curbing A Menace

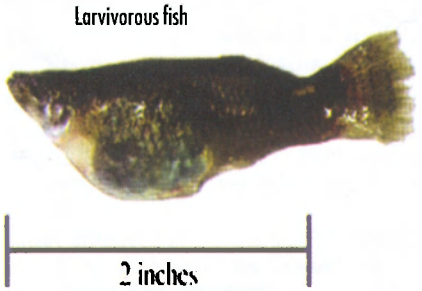
BISWA RANJAN MAHARANA & MANJIT PANIGRAHI

SINCE time immemorial millions and millions of people have been dying due to the menacing activity of a moving bombshell that transmits some of the world's worst life threatening and devastating diseases. This living jeopardy had once become the nightmare of one of the greatest scientists, Sir Ronald Ross (Nobel prize winner for Physiology in the year 1902). It is none other than the deadly mosquito.

Mosquitoes transmit many parasitic and viral diseases like Malaria, Chikungunya, Dengue, Filariasis, Westnile fever etc that are on the rise in many tropical and subtropical countries. Over the past few decades efforts have been made to develop mosquito control strategies by targeting the larval or the adult stages and use of biological agents and genetic engineering techniques against the disease-transmitting mosquitoes.

Chemical Methods

Pesticides including Organochlorine (DDT), Organophosphates (Malathion, Parathion), Carbamates (Carbaryl), Pyrethroids (Resermethrin, Sumithrin, Pyrethrin, Permethrin) are the most commonly used chemicals along with insecticides and impregnated bed nets such as Olyset nets recommended by WHO, which are currently in use in rural malaria endemic areas. On the other hand, insecticide-impregnated paint (Vernacide) and mosquito repellents (DEET, BITE BLOCKER/ GREEN BAN) are also in use these days. But unfortunately due to the rampant use resistance has developed in mosquitoes to almost every chemical class of insecticides.



Non-Chemical Methods

Surface-active agents (SAA) like Arosurf have effectively being used to control mosquitoes (*Aedes, Culex* and *Anopheles*). SAA enables better coverage of breeding habitats and is effective in controlling the larval population. Other non-chemical agents like expanded polystyrene beads (EPS) and insect growth regulators (IGRs) like Diflubenzuron, Methoprene, and Fenoxycarb are highly active against larvae of mosquitoes and other insects. The IGRs in general have a good margin of safety to most non-target biota and are relatively safe to man and domestic animals.

These compounds do not induce quick mortality in the early stages treated which is indeed a desirable feature of a control agent because larval stages of mosquitoes are an important source of food for fish and wild life. On account of selectiveness in their mode of action and potentiality in acting on target species, IGRs could play an important role in vector programs in the future. No likelihood of resistance has been reported against these IGRs. Ecdysone agonists are the ideal IGRs that inhibit developmental stages and are found to be effective against *Culex quinquefasciatus, Aedes aegypti, Anopheles gambiae* etc.

Biological Methods

In the last few decades, there is growing acceptance for alternate biocontrol agents that are currently being used in controlling larval populations in different breeding habitats. Biocontrol agents are natural predators, parasites or pathogens that could be used in maintaining the density of target organisms at a lower average. Some of the important advantages of biological control are:

- Low level of toxicity
- Resistance development is negligible
- Safe for humans and animals
- Persistence in environment is very minute
- Higher recycling potential

Modern researchers are inclined to use biocontrol agents rather than chemical insecticides due to the residual effects of chemical insecticides, widespread resistance in target insects, high refusal rate for indoor spray, soaring price of chemical insecticides and other operational difficulties. Effective biocontrol agents include predatory fish like Gambusia (*Gambusia affinis*), Guppies (*Poecilia reticulate*), cyprinids, Tilapia and killifish that have been used in many countries for controlling larva of *Anopheline* and *culicine* larva.

Recently, in Somalia, larvivorous fish *Oreochromis spilurus* was found to be effective against malaria vectors. Biocides or biolarvicides (bacilli-based

Parasitic wasps feeding on mosquito larvae (above)

Breeding habitats of mosquito (right)

Despite decades of international efforts we are still not in a position to completely control such a minute creature having immense potential to create havoc worldwide.

mosquito larvicides) like *Bacillus thuringiensis* subsp. *israelensis* (Bti) and *Bacillus sphaericus* (Bs) are sporeforming bacteria which upon sporulation produce a parasporal crystal toxic to some invertebrates, mostly mosquitoes and nematodes. Bti is toxic to both mosquito and blackfly whereas Bs only to mosquitoes. Both Bti and Bs, have shown great promise, particularly those breeding in highly polluted water.

Bti is now commercially available as Teknar, Deltox and Bactimos in different formulations (e.g. liquid concentrate and water dispersible powder). Bs is still undergoing the marketing process and is expected to be effective against all larval stages of *Anopheles, Culex* and *Aedes* mosquitoes. Prolonged efficacy of a combination of bacteria (Bti) and copepods (*Mesocyclops aspericornis*) in controlling immature forms of *Ae. aegypti* in peridomestic water containers was achieved in Thailand.

Other biological control agents such as cyclopoid copepods (*Mesocyclops pehpeiensis* and *Macrocyclops distictus*) are used as control agents against dengue vector *Aedes albopictus* in Japan. Protozoa like *Thelohania, Parathelohania, Nosema, Amblyospora* and *Vavraia* were found to be infective to many groups of mosquitoes. Researchers have also uncovered the biocontrol potential of dragonfly nymph like *Brachythemis contaminata* against the larvae of *Ae. aegypti, An. stephensi,* and *Cx. quinquefasciatus.*

Non-blood sucking predatory mosquitoes such as *Toxorhyncites splendens, T. brevipalpis, T. amboinensis* and *T. theobaldi* were found to be effective against mosquito larvae. Several viral genera such as cytoplasmic Polyhedrosis virus and iridescent virus have shown promising results in mosquito control. Entemopathogenic fungus like *Lagenidium, Culinomyces* etc have also shown their efficacy in controlling mosquitoes by killing them either at the larval or adult stages. Parasitic wasps are helpful in suppressing the mosquito population by killing them. Many scientists have also tried to control various genera of mosquito by genetic manipulation method commonly known as sterile insect technique (SIT). In 1962 and 1975 *Culex fatigans* and *Culex pipiens fatigans* were controlled in India by this novel approach.

Despite decades of international efforts we are still not in a position to completely control such a minute creature having immense potential to create havoc worldwide. Malaria is among the deadliest infectious diseases in the world and kills an estimated 1-3 million people every year. Mosquitoes are developing resistance to every group of chemicals including microbial drugs and insect growth regulators. If no new measures to fight against mosquitoes are initiated, the numbers of malaria cases are predicted to double in the next 20 years.

Among the new approaches being tried is a novel strategy to develop a transgenic mosquito (introduce into the mosquito a gene that interferes with the development of the malaria parasite). There are three basic requirements to achieve genetic modification of mosquitoes: (a) a method to introduce foreign genes into the germ line (transformation); (b) the availability of a suitable promoter to drive the expression of foreign genes in the appropriate tissue and at the appropriate time; and (c) the identification of appropriate gene products (effector genes) capable of interfering with the development of the malarial parasite.

But several loose ends have to be tied up before we can expect to release transgenic insects to block human diseases. Integrated pest management with conventional strategy as well as public awareness is highly indispensable to control such a tiny creature.

However, complete eradication of mosquito population is not desirable due to ecological constraints. Holistic and integrative approaches, although tedious and time consuming, are needed in a manner that maximizes the merits in terms of public health benefits.

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NATASHA DAS

What's your defence against mosquitoes? Mosquito repellent mats, creams, sprays, and nets... Has it ever crossed your mind that the nation's Defence Research and Development Organization, or the DRDO as we know it, is also working towards defending you from mosquitoes?

Defence Weaponry against Mosquitoes

"People who claim they don't let little things bother them have never slept in a room with a single mosquito."

DRDO has made significant contributions to India's strategic defence system over the last five decades. It often awes us with its contributions to the development of missiles such as Agni, Prithvi, Akash and Nag or the majestic battle tank Arjun. But the organization's efforts are not limited to the development of arms and armament systems. Some spinoff benefits of DRDO's efforts have found immense use for the society at large. One such line of research has helped provide defence against mosquitoes... one of man's deadliest enemies.

Some outcomes of DRDO's research include products such as the herbal mosquito repellent vaporizer (*Mosout*), room freshener-cum-mosquito repellent (*Aeromos*), water-based herbal mosquito repellent (*Aquamos*), poly herbal mosquito repellent (*Mosquit*), biological mosquito control agent (*Spheritox*), herbal floating tablet as mosquito larvicide (*Flotkil*) and the lure and kill technology (*Attracticide*).

Mosquitoes... Man's Deadliest Enemies

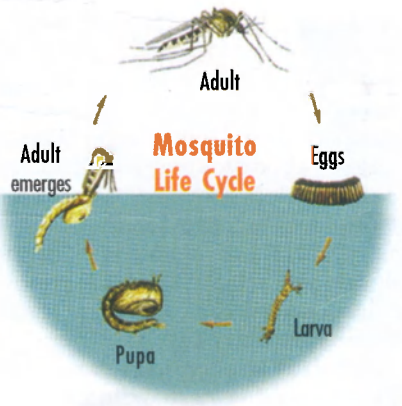
Mosquito bites are annoying. Worse, they cause serious diseases in humans, dogs, horses and other mammals. Mosquitoes make nearly 700 million people sick every year and that often results in millions of deaths globally. Malaria is the number one killer among infectious diseases in India. Dengue has also become a huge threat in India. According to the Ministry of Health and Family Welfare, in 2008 alone the country recorded over 12,000 cases of dengue. This is more than double recorded in the year 2007.

Other than these two more common diseases, different types of mosquitoes also transmit worms, viruses and parasites that cause diseases such as

- Filariasis (an infection by round, thread-like parasitic worms that inhabit the lymphatic system);
- Chikungunya (a viral illness causing fever and severe joint pain);
- Yellow fever (a potentially fatal acute viral hemorrhagic fever);
- Epidemic polyarthritis (an influenza-like illness associated with inflammation and pain of multiple joints in the body);
- Rift Valley fever (a viral zoonosis that may infect humans);
- West Nile fever (a viral infection that can cause fever, skin rashes and inflammation of the brain and its surrounding meninges) and;
- Japanese encephalitis (a serious illness causing inflammation in the brain).

Know Thy Enemy

There are about 3500 species of mosquitoes. They go through four distinct stages during their lifecycle. When magnified under a microscope, the different stages will look as shown in the figure. First an adult mosquito lays eggs in stagnant water. Then the larva comes out of it. It turns into pupa out of which adult mosquito emerges. After it dries its wings it is ready to fly. Interestingly, male mosquitoes do not bite. They typically feed on nectar and other plant juices. Only the females of some species need a 'blood meal' to be able to produce eggs.



DRDO's Arsenal against Mosquitoes

DRDO has targeted several different modes of mosquito control.

DEPA spray

Its Life Sciences wing has developed a multi-insect repellent spray whose main constituent was N, N-diethylphenylacetamide (DEPA). This spray provided 6-8 hrs of protection from mosquito bites. The product is now approved by the Drugs Controller General of India (DCGI) and also the Director General of Armed Force Medical Services. Once sprayed on fabric, curtains or even skin, the DEPA spray keeps mosquitoes away for 6 to 8 hours.

The technology of spray formulation has been transferred to Confederation of Indian Pharmaceutical Industry (CIPI) for commercial production with BIS specification IS 14187. It would now be brought to the market for the "aam aadmi" by Jyothi Laboratories and Asian Herbex Ltd.

Anti-mosquito paint for your rooms

A slow release insecticidal paint developed by DRDO adds a new dimension to paint technology. In addition to decoration and preservation of wooden and metallic surfaces, this new paint keeps away mosquitoes, cockroaches and other insects by slowly releasing the safe

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insecticide from the blended paint, achieved through a delicate balance of chemical formulation. It is a quick-drying paint with insecticidal activity for two years. The paint is ideally suited for use in kitchens, restaurants, warehouses, hospitals, rail coaches, etc.

Herbal mosquito repellants

If you thought insecticidal chemicals were toxic and dangerous for the environment, here's something interesting. DRDO has identified nearly twenty indigenous plants whose extracts and oils have been found to be effective against the larvae of mosquitoes. An herbal mosquito-repellent in spray formulation has been developed. It is also equally protective against fleas, bed bugs, and other blood-sucking insects. Another herbal insect-repellent cream with a coconut oil base when applied on the skin provides protection for five to six hours.

In a short communication published in the October 2006 issue of the *Defence Science Journal*, scientists from the Defence Research Laboratory (DRL) at Tejpur pointed out that the bioactive organic chemicals obtained from plant sources had been found to be less toxic and less prone to development of resistance than other synthetic insecticides. Moreover, they were also easily biodegradable and more cost effective.

Concerned about the effects of chemical vapors released from some synthetic mosquito repellants on the health and hygiene of children in your house? Here's an option you might want to try ... the herbal mosquito repellant vaporizer from DRL's quiver. This eco-friendly herbal formulation is 100% natural and evaporates slowly with fragrance to keep away mosquitoes and other biting insects. A patent has been filed for this product and the user trial has been completed. The transfer of technology for commercial production is in the pipeline. Once in the market, this could well be a safe alternative to synthetic anti-mosquito vaporizers.

Non-electric mosquito repellent liquid vaporizer

When you are camping outdoors in a tent with no electricity, you have to do without your electric mosquito repellent vaporizer. Moreover, electricity is yet to reach many remote villages of the country. In such conditions, DRDO's non-electric mosquito repellent liquid vaporizer comes in handy. The "Mosquito Vaporizer" kit consists of a kerosene oil burner that emits heat. This vaporizes the herbal liquid integrated to the burner. The vapours thus emitted repel the mosquitoes away.

Mosquito biolarvicide

Generally, synthetic insecticides are used to kill mosquitoes. These are not eco-friendly. DRL, Tezpur has been successful in developing a mosquito biolarvicide of 10% powder formulation using a kind of soil bacteria called *Bacillus sphaericus*.

The bacteria act against the larvae of *Culex* and *Anopheles* mosquitoes through a toxin that is released upon destruction of the bacterial cell wall. The toxin causes disintegration of the gut wall, cessation of feeding activity, starvation and leakage of gut contents into the circulatory fluid or hemolymph and the body cavity of the mosquito larvae causing paralysis or death.

A Knapsack sprayer is used to spray the larvicide uniformly over the surface of water where mosquitoes breed. The user trial for this product is in process.

Herbal Floating Tablet Mosquito Larvicide

Spraying of mosquito larvicides is fine. But how do you spray a larvicide into tree holes where water collects...or maybe even collection of water in smaller pots and containers? We hardly hire somebody to spray a larvicide into our coolers where we know mosquitoes so often breed.

DRDO has a solution. It has developed a technology for control-release of herbal larvicide called "Herbal Floating Larvicide Tablet" or Floatkil. It is a larvicide tablet with biodegradable herbal floating and binding materials impregnated with it. The tablet is effective for 30 days. One single tablet is sufficient for one square meter of open water surface.

But won't the mosquitoes start laying eggs again? In a few weeks' time, won't their population inevitably increase as they start developing resistance? DRDO comes to your rescue once again. It has developed an 'attracticide' that has 'lure and kill' properties.

Lure and kill attracticide

Aedes aegypti mosquitoes prefer to lay eggs on water containing the larvae of the same species. Even after the larvae are removed, for several weeks the larval water seems to attract adult mosquitoes to lay eggs in the same place. Pheromones or sex hormones seem to play a role here. For the first time in the world, DRDO has been able to isolate and identify these pheromones. It has also been successful in producing these sex hormones synthetically.

Using this attractant along with insect growth regulators, the DRDO has formed an attracticide that lures female mosquitoes into laying eggs in the water containing such attractant. Though the eggs hatch into larvae, they do not reach adulthood.

Field trials in Delhi, Maharashtra, Kerala and Tamil Nadu have confirmed the effectiveness of this 'lure and kill' technology in controlling the population of *Aedes aegypti* mosquitoes. This technology is patented in India. Technology transfer to a US-based firm, Crompton Corporation, is under progress.

When you go to bed, remember to be thankful to the research scientists at DRDO for their constant efforts in making your lives more peaceful even as you sleep.

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Website: www.natashamedicalwriting.com

Prize Puzzle

HIDDEN BIRDS

Names of 3,4,5 and 6 birds are hidden in the first, second, third & fourth sentences, respectively. Search them and arrange their initials to name the four common mammals.

1. Some good overs were bowled by Gulloo.

   Birds: (1)_____ (2)_____ (3)_____

   Mammal _____

2. Adjutant Robinder regretted when he was late for parade.

   Birds: (1)_____ (2)_____ (3)_____ (4)_____

   Mammal _____

3. Adjutant K.K. Khullar kept waiting for my native B.C. Rane who regretted for being late.

   Birds: (1)_____ (2)_____ (3)_____ (4)_____ (5)_____

   Mammal _____

4. Adjutant H.S. Bhullar kept his kite flying while adjutant Vijay C. Rane enjoyed watching it.

   Birds: (1)_____(2)_____(3)_____(4) _____(6)_____

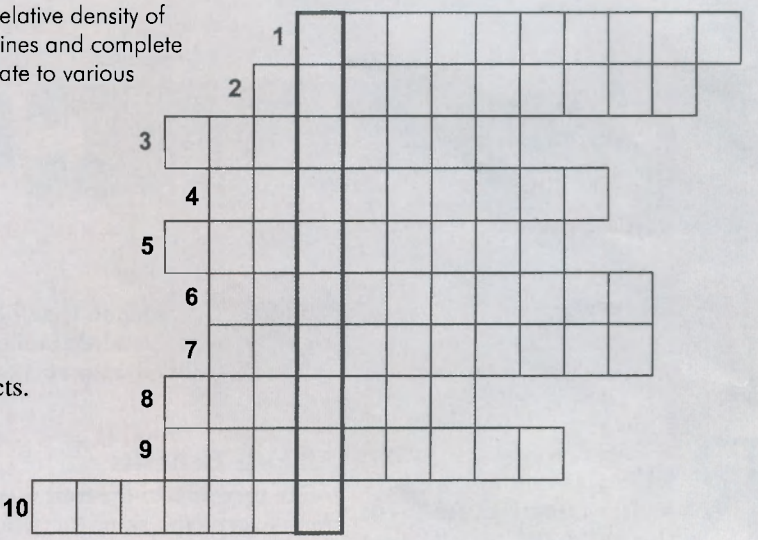
   Mammal _____

Contributed by Mr Sawinder Singh, H.No. 106, Ward No 6, Street No 1, Rulia Ram Colony, Gurdaspur-143521, Punjab

INSTRUMENT PUZZLE

Name the instrument that is used for measuring the relative density of liquids. Write it down vertically in the box with thick lines and complete the puzzle based on the clues given. All the clues relate to various scientific instruments.

1. Shows changes in atmospheric humidity
2. Used for viewing below the surface of water.
3. Measures altitudes and angles in navigation
4. Measures high temperatures
5. Measures atmospheric pressure
6. Reverses the direction of an electric current.
7. Measures the velocity of wind.
8. Measures the angular distances between objects.
9. Used for viewing distant objects as magnified.
10. Measures strength of an electric current.



Contributed by Mr Santosh Kumar Mishra, S/o Narayan Mishra, At-Beleswar, PO-Nayabazar, Dist-Cuttack-753 004, Orissa

SPLIT & SCRAMBLE

Split the following 6 x 6 square into four sections of the same size in such a way that there are 9 letters in each section. Then rearrange these nine letters in each section to write the four names of four branches of science.

M	Y	T	O	S	N
O	A	R	C	O	C
S	T	U	A	I	S
M	S	H	Y	E	I
T	C	R	C	E	H
A	M	T	S	N	C

Contributed by Mr Sawinder Singh, House No 106/6, Street No 1, Rulia Ram Colony, Gurdaspur-143521 (Punjab)

Solutions to the puzzles published in the May 2010 issue:

PRIZE PUZZLE: Pepper Puzzle

18 peppers

Find the Mathematical Curves

Limacon, Hyperbola, Cissoid, Conchoid, Cycloid, Bullet nose Curve, Trisectrix, Chainette, Brachistochrone, Rhodonea Curve, Bernoulli Spiral, Lemniscate, Cardioid, Witch of Agnesi, Astroid, Ellipse, Catenary, Lituus, Bicorn, Circle

Ore Search

1. GYPSUM 2. HAEMATITE
3. DOLOMITE 4. BAUXITE
5. CINNABAR 6. MAGNETITE

The word is GALENA.

The names of the prizewinners based on a draw of lots from among the correct entries are:

(1) Pankaj Kumar, 55 Amar Park, Vill. Jassian, Haibhwal Kalan, Ludhiana-141001, Punjab

(2) Siddhant Mishra, 2682/C, I-A, C/o Commandant, RIMC, Garhi Cantt., Dehradun-248003, Uttarakhand

(3) Tanmay Vaibhav, E-305, Rajkishori Complex, Muchhad Path, Kankarbagh, Patna-800020

Congratulations all the winners!

S. LAL, N. AHMED, S.R. SINGH,
D.B. SINGH, J.I. MIR & R. KUMAR

Kiwifruit: Miracle Berry

REFRESHING, delicate flavour with pleasing aroma, and high nutritive value are the hallmarks of the ripe kiwi fruit. The kiwifruit (*Actinidia deliciosa*) or Chinese gooseberry is also popularly known as 'China Miracle Fruit' and 'The Horticultural Wonder of New Zealand'. It is a large, woody, deciduous vine native to the Yangtze Valley of China and was introduced into India in the 1960s.

Approximately 84% of the world production is contributed by China, Italy, New Zealand, and Chile. In India, the area under this fruit is negligible. The average experimental farm productivity of kiwifruit in our country is about 25 tonnes/ha as compared to New Zealand's 28.63 tonnes/ha.

With extensive research and development support, its commercial cultivation in India has been extended to the mid-hills of Uttarakhand, Himachal Pradesh and parts of North Eastern States. In Jammu & Kashmir, in the Jammu region, it is being cultivated in Ramban in sizable area but other sub temperate and temperate regions like Udampur, Doda, Kupwara, RS Pura, and Kashmir valley also have enormous potential.

The plant will grow satisfactorily under moderate to high rainfall conditions. Kiwifruit requires 700-800 chilling hours below 7 °C. The summer temperature should not go beyond 35°C.

It is mostly eaten as fresh fruit or combined with other fruits in salads and desserts. The nutritive value and flavour are retained when the fruit is processed to jam, jelly or preserves. The fruit is rich in vitamin C and contains an enzyme that tenderizes meat, thus it can be rubbed into steaks before boiling.

Health Benefits

More than 90% of the fruit is edible. In fact, except the skin, the whole fruit along with seed is edible. Almost all the ingredients are available in kiwi fruit compared to other existing fruit crops. It is the most nutrient-rich of the top 26 fruits consumed in the world today. It also has the highest density of any fruit for vitamin C and magnesium—a limited mineral in the food supply of most of the developing countries and a nutrient important for cardiovascular health.

Among the top three low-sodium, high-potassium fruits, kiwifruit ranks number one, having more potassium than a banana or citrus fruits. Based on scientific literature and the U.S. Food and Drug Administration's (FDA) approved legal definition of a good (>10% of the daily value (DV)) or excellent (>20% of the DV) source, kiwifruit is classified as an excellent source of vitamin C as well as dietary fiber. By the FDA's definition, kiwifruit is also a good source of vitamin E and potassium.

Kiwifruit has low fat and contains no cholesterol. Unlike other fruits, it has an unusually broad complement of nutrients not only in the flesh but even in the seed. In seeds, the oil contains on average 62% alpha-linolenic acid, an omega-3 fatty acid. Most fruits tend to be high in only one or two nutrients, but kiwifruit delivers 8% DV of folic acid, 8% DV of copper, 8% DV of pantothenic acid, 6% DV of calcium and magnesium, 4% DV of iron and vitamin B6, 2% DV of phosphorus and trace amounts of vitamin A (beta carotene) and other vitamins and minerals.

Medicinal Value

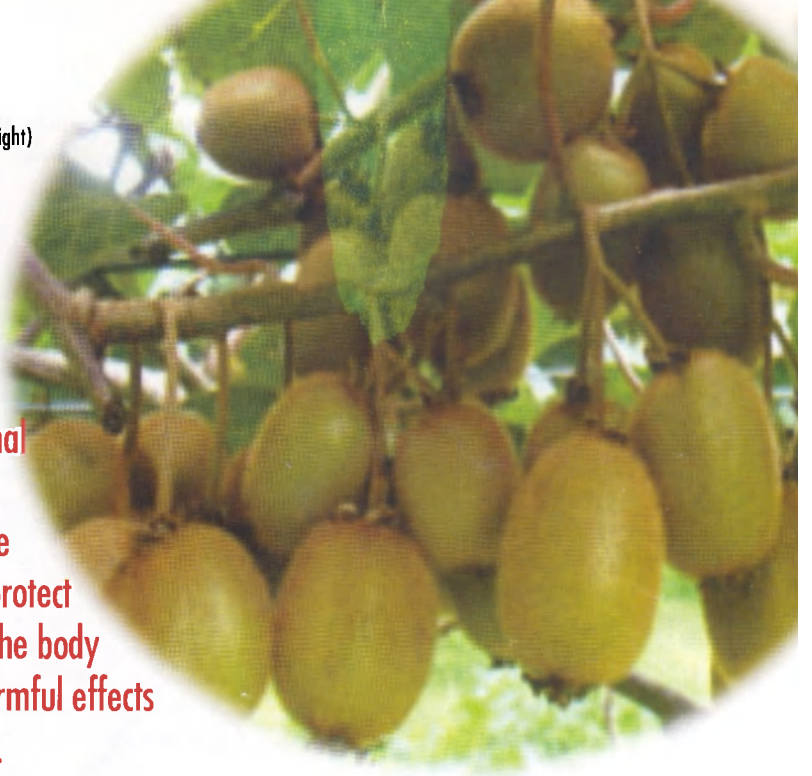
Health benefits of kiwifruit are attributed to a high content of specific minerals, vitamins and phytonutrients like carotenoids and essential fatty acids. There are many medicinal uses of kiwifruit.

Table 1: **Nutrient composition of a fully ripe kiwifruit**

Nutrients: Content per 100 g of kiwifruit		
Energy 217 kJ (51 kcal)	Minerals	Vitamins
Water 83.8 g Protein 1.0 g Lipid 0.6 g Carbohydrate 9.3 g Organic acids 1.5 g Fiber 3.9 g Minerals 0.7 g	Sodium 4 mg Potassium 295 mg Magnesium 25 mg Calcium 40 mg Iron 800 µg Phosphorus 30 mg Chloride 65 mg	Carotene 370 µg Vitamin B1 17 µg Vitamin B2 50 µg Nicotinamide 410 µg Vitamin C 20-300 µg
Organic acids	Carbohydrates	
Malic acid 500 mg Citric acid 990 mg Oxalic acid traces Salicylic acid 320 µg	Sucrose 1250 mg Glucose 4490 mg Fructose 3540 mg	

Hayward variety in bearing

Unripe kiwifruit (right)



Flavonoids present in the fruit increase the nutritional value of kiwifruit. The flavonoids protect the cells of the body from the harmful effects of oxidation.

Cancer: Kiwifruit contains an antimutagenic component, helping to prevent mutations of genes that may initiate the cancer process. The presence of glutathione may account for the reduction. Carcinogenic nitrates are formed during the smoking or barbecuing of foods. When nitrates are ingested, a process called nitrosation occurs, in which free radical nitrosamines are formed that may lead to the formation of gastric or other cancers.

The amino acid arginine, present in kiwifruit, is being looked at by cardiologists to improve post angioplasty blood flow and actually prevent the formation (or reformation) of plaque in the arteries. Kiwifruit is ranked as having the fourth highest natural antioxidant potential next to the red fruits containing high levels of beta-carotene. Lutein, an important phyto-chemical found in kiwifruit, has been linked to the prevention of prostate and lung cancer.

In addition to kiwifruit being recognized by the FDA as an excellent source of dietary fiber, studies indicate that it contains another not-yet-isolated compound that accelerates digestive transit time even faster than dietary fiber alone, which is important for colorectal cancer prevention. The benefit of this laxative action is to decrease the build-up of cancer-promoting metabolites. Kiwifruit is one of the few fruits that are green at maturity, and chlorophyll is responsible for that color and chlorophyllin, a derivative of chlorophyll, is an inhibitor of liver carcinogenesis.

Fully mature fruit on tree

Cardiovascular Disease: Platelet hyperactivity is one of the most important risk factors responsible for the incidence of cardiovascular disease. There are many nutritive and non-nutritive compounds present in the fruits and vegetables that may affect platelet function in various ways. The recent discovery of anti-platelet factors in kiwifruits provides a new dietary means as a preventive or therapeutic strategy to favorably modify platelet activity.

Horizontal section of ripe fruit

Kiwifruit is also particularly high in two amino acids: arginine and glutamate. Arginine may help promote an increase in arteriolar dilation, working as a vasodilator and improving blood flow important for heart health. Fruits thin your blood, reduce clotting (Platelet aggregation) by an average of 18%, and lower your fat in the blood (triglycerides) by an average of 15%

Depression: Inositol found in kiwifruit functions as a precursor of an intracellular second messenger system. It is beneficial in the treatment of depression.

Diabetes: Inositol, a sugar alcohol naturally occurring in kiwifruit, plays a positive role in regulating diabetes. Inositol supplements improve nerve conduction velocity in diabetic neuropathy. Inositol plays a role in intracellular responses to hormones and neurotransmitters. It acts as a second messenger in cell signaling processes.

Eye Health/Macular Degeneration: Kiwifruit is rich in phyto-chemical xanthophylls and especially a subcomponent, lutein. Lutein is known to accumulate in the retina of the eye. These important compounds are important to prevent macular degeneration, the leading cause of irreversible blindness. Kiwifruit contains a wealth of carotenoids (beta carotenes, luteins and xanthophylls);

Popular Kiwifruit Varieties in India

Hayward: Most popular variety, late maturing, having large size attractive fruits with maximum shelf life, superior in flavour and has high content of sugar and Vitamin C.

Monty: A chance seedling, late flowering but fruit maturity is earlier. Fruits are oblong somewhat angular, widest at apex, medium in size, prolific bearer.

Abbott: A chance seedling, early flowering & maturing. Fruits are oblong, covered with dense hair.

Allison: Fruits are oblong, slightly broader than Abbott, medium in size with densely hairy brownish skin and flavored greenish flesh.

Bruno: Fruits are slightly tapering in shape towards the stem end. It is the longest among the fruits, fruits are dark brown having dense, short and bristly hairs. Heavy bearer with good content of Vitamin C.

Except the skin, the whole fruit along with seed is edible. It is the most nutrient-rich of the top 26 fruits consumed in the world today. It also has the highest density of any fruit for vitamin C and magnesium.

phenolic compounds (flavonoids and anthocyanins) and antioxidants, including vitamins C and E. The excellent complement of antioxidants in kiwifruit may help prevent the oxidation of the good cholesterol (HDLs).

Nutrient Dense: Kiwifruit is the most nutrient dense fruit among all fruits—almost twice the Vitamin C of an orange, and over 20% more Potassium than a banana. Kiwifruit also provides 24% of the RDA of Vitamin C, 10% of the RDA of Vitamin E, 10% of the RDA of Folate, 9% of the RDA of Potassium, 8% RDA of Copper, 6% of the RDA of Magnesium, 6% of the RDA of Calcium, 4% of the RDA of Iron. Kiwifruit is especially rich in Lutein, and provides 16% of the RDA of fiber, which is beneficial in many ways for the human body.

Hypertension: Cardiologists believe the sodium-to-potassium ratio is critical for heart health. That ratio is extremely favorable in kiwifruit. Kiwifruit contains magnesium at 6% DV. Magnesium is thought to be in short supply in the diets of affluent countries. Poor magnesium status is associated with heart disease, myocardial infarction and hypertension

Immunity: · Kiwifruit has been shown to be an immune booster most likely due to its extremely high vitamin C content and its complement of antioxidant compounds.

Impotence: Kiwifruit contains the amino acid arginine, a well-known vasodilator that has been used to treat impotence in men.

Physical Fitness: Kiwifruit contains a wide range of minerals (electrolytes) essential for replenishing those lost during exercise especially in hot environments. It is also a naturally significant source of electrolytes for a pre-workout regimen.

Stress Reduction: Kiwifruit contains a relatively high level of serotonin. Serotonin causes a calming effect in most individuals.

Weight Control: Kiwifruit is one of the most nutrient-rich fruits. It is has the best balance of nutrients per calorie (the most nutrients for the fewest calories) from kiwifruit, cantaloupe, papaya and lemons.

Radiating seeds array

Respiratory Health: The consumption of vitamin C rich foods such as kiwifruit, even in small quantities, may reduce respiration related health problems in childhood.

Other Benefits of Kiwifruit

- It is specifically useful in treating asthma in children.
- The high fiber content also has a mild laxative effect. Hence, it is useful in dealing with constipation.
- Flavonoids present in the fruit increase the nutritional value of kiwi fruit. The flavonoids protect the cells of the body from the harmful effects of oxidation. It also minimizes the chances of DNA mutations occurring within the cells.
- It facilitates absorption of iron, thus preventing anemia.
- Folate in kiwi plays an important role in cell development in pregnant women.
- Kiwi fruits are rich in anti-oxidants that reduce signs of aging considerably. Ascorbic acid present in this fruit is an excellent astringent. It provides great result in tightening the skin and the pores on it.
- Consumption of kiwifruit strengthens metabolism and improves nerve function.
- It also helps to maintain proper fluid balance in the body.

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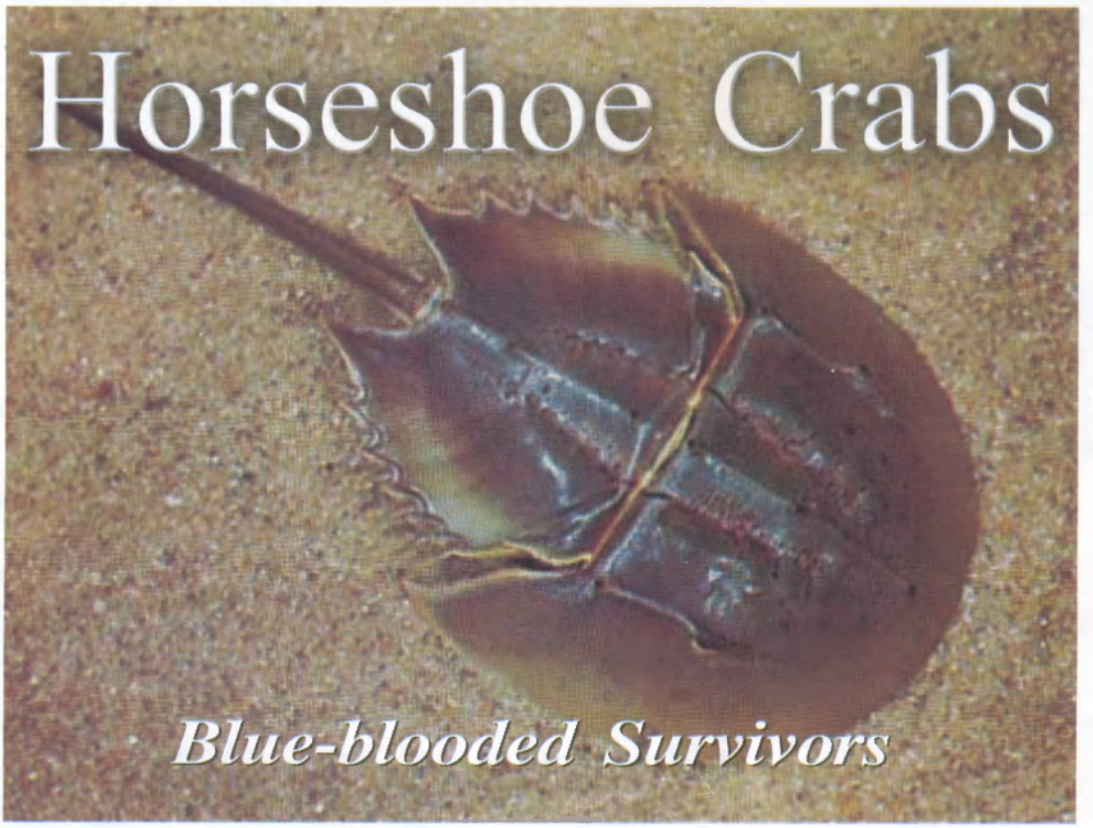
Horseshoe Crabs



Blue-blooded Survivors

It lived at a time when plant and animal life on land was just getting established. Scientists think that even older fossils may exist that will push back Horseshoe crab lineage to 490 million years.

Blue-blooded human aristocrats are proud of their lineage that can be traced back to many generations. By that token at least, they should be honoured to acknowledge the Horseshoe crab as a literally blue-blooded peer with a lineage pre-dating the Dinosaurs.

These animals can claim a history that reaches back almost half-a billion years. In 2008, a paper in the British journal *Palaeontology*, reported that a team of Canadian scientists had found Horseshoe crab fossils from 445 million year-old rocks in central and northern Manitoba, Canada. The new fossil species was named *Lunataspis aurora*. It lived at a time when plant and animal life on land was just getting established. Scientists think that even older fossils may exist that will push back Horseshoe crab lineage to 490 million years.

In 1588, British naturalist Thomas Hariot named these "Horse-foot" crabs, which over time, was changed to "Horseshoe." Horseshoe crabs are Arthropods and belong to Class Merostomata (from the Greek words *meros*, meaning leg, and *stoma*, or mouth). Although called "crabs," they're not crabs but distant cousins to spiders and scorpions. Their close relatives were the Trilobites that existed 544 million years ago.

Horseshoe crabs are currently represented by four living species. The Atlantic Horseshoe crab is called *Limulus polyphemus*. The Japanese Horseshoe crab is called *Tachypleus tridentatus*. The two species that occur along the east coast of India are *Tachypleus gigas* and *Carcinoscorpius rotundicauda*. All the four species look essentially similar. The upper side of the body is entirely covered with a hard, horseshoe-shaped shell, and it has a long, spinelike tail. Its blood contains a copper-based respiratory pigment called hemocyanin that gives the blood a bluish hue.

It is awe-inspiring to realize that since pre-history, despite the massive re-organization of the Earth's surface into the continents we recognize, Ice ages and the many extinction events, Horseshoe crabs have survived. Actually, they are very much what they looked like millions of years ago. This is precisely why Horseshoe crabs are called "Living fossils." As David Rudkin, Royal Ontario Museum, Toronto succinctly sums it up, *"They made it through all of these events, not necessarily unscathed, but in a continuously recognizable form."*

Despite their hoary lineage, it has been estimated that fishermen chop up 20,000 to 25,000 Horseshoe crabs per year as bait. They are also caught for use by the pharmaceutical industry. A protein in the blood of the Horseshoe crab provides a valuable medical product critical to maintaining the safety of many drugs and medical devices. This protein is used to test products for the presence of bacterial toxins that can cause fevers and which can even be fatal to humans.

Japan has built the world's first-ever Museum dedicated to the Horseshoe crab. This is the Kasaoka City Horseshoe Crab Museum built in 1990 to promote appreciation and interest in the conservation of *Tachypleus tridentatus*. In addition to educational exhibits, the museum rears Horseshoe crab larvae for release into the wild. Museum scientists use radio telemetry to track migration patterns, identify over-wintering grounds, and locate potential spawning beaches. Since habitat destruction and over-exploitation are major threats for these animals, it is hoped that the Museum's efforts will help this ancient coastal creature retain its tenuous hold on life.

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"Go with the Flow," some philosophers urge. However, scientists caution that this may not be the best advice to follow if it is a Pyroclastic Flow that you are planning to go with. In that case, run far away from the fearsome flow, they say.

Fearsome Flows

Pyroclastic Flows

The word Pyroclast comes from the Greek words for "fire" and "broken." Literally it means "Fire of broken rocks," and thus refers to fragmented or clastic rock material formed by a volcanic explosion or ejection from a volcanic vent. As the name hints, pyroclastic flows are fluidized masses of rock fragments and gases that move rapidly under the force of gravity. To observers it looks like a billowing grey cloud descending the volcanic slopes with great speed. This devastating cloud of hot gas, ash and rock (collectively called Tephra) flows down the sides of a volcano much like a snow avalanche. Gases within a pyroclastic flow can explode and cause ash to rain down on nearby areas. The tremendous energy of the moving boulders uproots trees and flattens buildings encountered on the way.

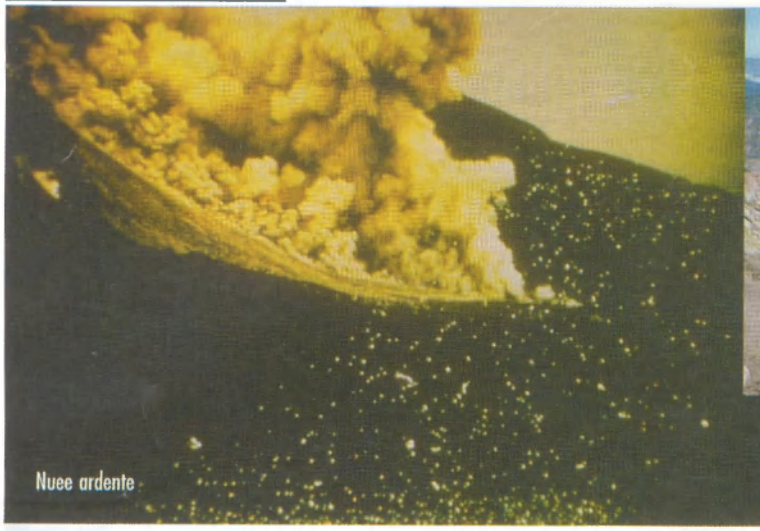
Pyroclastic Flows

Fast-moving Flows: Pyroclastic flows move swiftly – at around 150 km/h. This swiftness is partly because of its fluidization and the extremely low inter-particle friction. A moving pyroclastic flow has properties more like those of a liquid than a mass of solid fragments. Interestingly there is evidence that pyroclastic flows can even move over water. Of the 60 km of its course, the 6000-year-old Koya flow (Japan) had travelled ten kilometres over open water!

Pyroclastic flows usually consist of two parts: the basal flow touches the ground and contains large boulders and rock fragments. An ash cloud or plume produced by the turbulence between the flow and the overlying air rises above it. Ash may rain from the cloud over a wide area downwind from the basal flow.

Sizzling Hot: Pyroclastic flows can also be fiercely hot. The gas is usually at a temperature of 100-800 degrees Celsius. When Mt. Pelee (Caribbean Islands) erupted in 1902, pyroclastic flows with temperatures as high as 1075 degrees Celsius travelled rapidly downhill destroying everything in their path. These flows completely destroyed St. Pierre, Martinique. Almost all its 30,000 residents died, mostly from asphyxiation by hot ash and gases. Only two reportedly survived. One, because he was in a dungeon-like cell and the other, living at the edge of the city escaped with burns. Historically, similar pyroclastic flows destroyed Pompeii and Herculaneum in 79 AD. Even today, pyroclastic flows kill more people than any other event associated with a volcanic eruption.

Pompeii victim

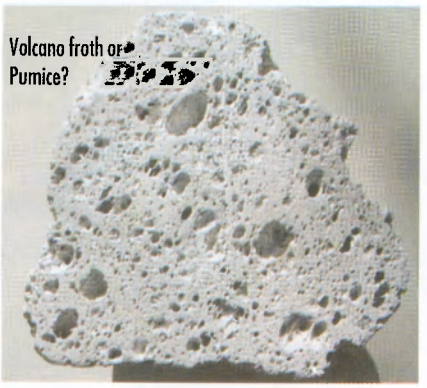


Pyroclastic surges are hazardous because these can travel upwards, which to most observers appears a counter-intuitive direction.

Types of Pyroclastic Flows

Pyroclastic flows are of two types:

■ *Ignimbrites:* Ignimbrites contain fist-sized fragments of pumice floating in a finer-grained matrix. These flows can extend 200 km from their source. Such pumice-rich flows usually result from the collapse of an eruption column that is formed when a volcano spews hot volcanic ash into the atmosphere. The lowermost part of the eruption column is called the gas thrust region. Sometimes, this region becomes absolutely loaded with debris and it collapses downward under gravity and a huge mass of pumice flows down the flanks of the volcano.



■ *Nuee ardente: Nuee ardente* means "glowing cloud" in French. The French geologist Alfred Lacroix gave this name to the pyroclastic flow from Mt. Pelee. This particular pyroclastic flow was triggered by the explosive collapse of a lava dome at the summit of the volcano. A lava dome is a roughly circular protrusion formed from the slow extrusion (as opposed to eruption) of lava (like thick toothpaste) from a volcano; the high viscosity of which prevents it from flowing very far.

The term *Nuee ardente* is applied to all pyroclastic flows generated by dome collapse but some scientists point out that a better term would be "glowing avalanche." Much of the *Nuee ardente* hugs the ground as it moves but an overlying cloud of fine ash particles hang over it. These particles are winnowed out of the actual flow by a process termed elutriation. Thus, *Nuee ardentes* is best described as, "a pyroclastic avalanche largely hidden from view by an overlying ash cloud." Since it was associated with Mt. Pelee, *Nuee ardente* eruptions are also called Peleen eruptions. *Nuees ardentes* have been known to extend 50 kilometres from their source.

Pyroclastic flows can transform into lahars posing even greater hazards or even generate pyroclastic surges.

Pyroclastic Surge

A pyroclastic surge is a fluidized mass of turbulent gas and rock fragments which is ejected during some volcanic eruptions. It is similar to a pyroclastic flow but contains a much higher proportion of gas to rock. The large volume of gas coupled with the lack of enough particles makes these flows turbulent and extremely swift. It also allows such flows to rise uphill over ridges rather than always travel downhill as pyroclastic flows do.

Pyroclastic surges are much faster moving than pyroclastic flows but these usually do not travel as far as pyroclastic flows and are limited to about 10 kilometres from the source. However, in destructive ability pyroclastic surges match pyroclastic flows because of their enormous kinetic energy and the lethally hot and asphyxiating gas that they contain.

Pyroclastic surges are of two types:

■ "Hot" pyroclastic surges consist of "dry" clouds of rocky debris and gases that have temperatures appreciably above 100 degrees Celsius.

■ "Cold" pyroclastic surges, also called base surges, are made up of rock debris and steam/water at/below 100 degrees Celsius. Cold surges usually happen where magma comes in contact with water at volcanic vents near crater lakes etc.

Pyroclastic surges are hazardous because these can travel upwards, which to most observers appears a counter-intuitive direction. The pyroclastic surge that killed the famous volcano hunters Katia and Maurice Krafft (and 41 others) on Mt. Unzen (Japan) on 3 June 1991 rose over the spur on which they were standing and engulfed it. Today, the Krafft Medal is given to an individual who has made outstanding contributions to vulcanology through service to the scientific community or to communities threatened by volcanic activity.

Krafft Medal

Dr Sukanya Datta
Scientist, NISCAIR, posted to Director General's Technical Cell, CSIR HQ
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FAMOUS PHYSICISTS

HIMANSU SEKHAR FATESINGH

1. The first woman to receive the Nobel Prize in physics was
a. Maria G. Mayer
b. Irene Curie
c. Marie Curie
d. Lise Meitner

2. Who first suggested electron shells around the nucleus?
a. Ernest Rutherford
b. Neils Bohr
c. Erwin Schrodinger
d. Wolfgang Pauli

3. He first measured negative charge on an electron.
a. J. J. Thomson
b. Clinton Davisson
c. Louis de Broglie
d. Robert A. Millikan

4. The existence of quarks was first suggested by
a. Max Planck
b. Sheldon Glasgow
c. Murray Gell-Mann
d. Albert Einstein

5. The phenomenon of superconductivity was discovered by
a. Heike Kamerlingh Onnes
b. Alex Muller
c. Brian D. Josephson
d. John Bardeen

6. He first succeeded in producing the nuclear chain reaction.
a. Otto Hahn
b. Fritz Strassmann
c. Robert Oppenheimer
d. Enrico Fermi

7. The credit for discovering electron microscope is often attributed to
a. H. Germer
b. Ernst Ruska
c. George P. Thomson
d. Clinton J. Davisson

8. The wave theory of light was first proposed by
a. Christiaan Huygens
b. Isaac Newton
c. Hermann Helmholtz
d. Augustin Fresnel

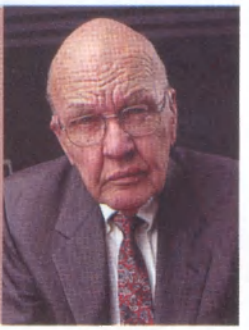
9. He was the first scientist to find proof of Einstein's theory of relativity
a. Edwin Hubble
b. George Gamow
c. S. Chandrasekhar
d. Arthur Eddington

10. The credit for development of the cyclotron goes to:
a. Carl Anderson
b. Donald Glaser
c. Ernest O. Lawrence
d. Charles Wilson

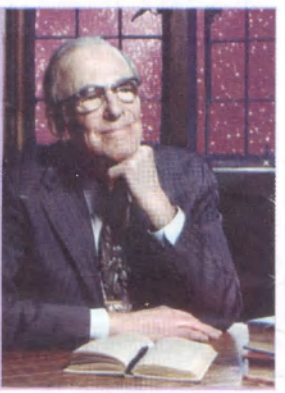
11. Who first proposed the use of absolute scale of Temperature?
a. Anders Celsius
b. Lord Kelvin
c. Rudolf Clausius
d. Gabriel Fahrenheit

12. The principle of electromagnetic induction was discovered by
a. Michael Faraday
b. Joseph Henry
c. Nikola Tesla
d. Hans C. Oersted

13. He invented integrated circuit, the forerunner of the computer microchip.
a. John Bardeen
b. Jack S. Kilby
c. William Shockley
d. Gordon Moore



14. The theoretical physicist who first proposed placing telescopes in Space was:
a. James Webb
b. S. Chandrasekhar
c. Edwin Hubble
d. Lyman Spitzer



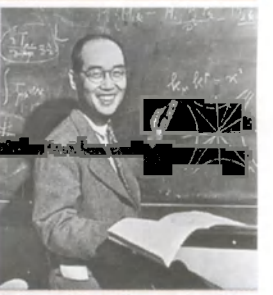
15. Who first proposed that light is a form of electromagnetic radiation?
a. James Clerk Maxwell
b. Heinrich Hertz
c. Wilhelm Weber
d. Max Planck

16. The first accurate measurement of the velocity of light was made by.
a. Albert Michelson
b. Armand Fizeau
c. Jean Foucault
d. Galilei Galileo

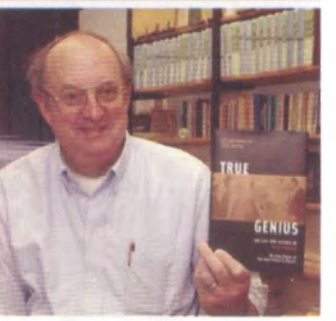
17. He first formulated the uncertainty principle.
a. Clinton Davisson
b. Max Planck
c. Werner Heisenberg
d. Louis de Broglie

18. Which of the following physicists developed holography?
a. Charles H. Townes
b. Dennis Gabor
c. Edwin Hall
d. Theodore Maiman

19. The elementary particle meson was envisaged by
a. Victor Franz Hess
b. Carl Anderson
c. Cecil F. Powell
d. Yukawa Hideki



20. He is the only physicist to receive two Nobel Prizes in same categories.
a. Albert Einstein
b. Max Planck
c. John Bardeeen
d. James Clerk Maxwell



21. His postulate imposes restriction on the size of a white dwarf. Who is he?
a. Edwin Hubble
b. S. Chandrasekhar
c. S. N. Bose
d. Sir Fred Hoyle

ANSWERS:

1. c	2.b	3.d	4.c	5.a	6. d
7. b	8.a	9.d	10.c	11.b	12.a
13.b	14.d	15.a	16.a	17.c	18.b
19.d	20.c	21.b			

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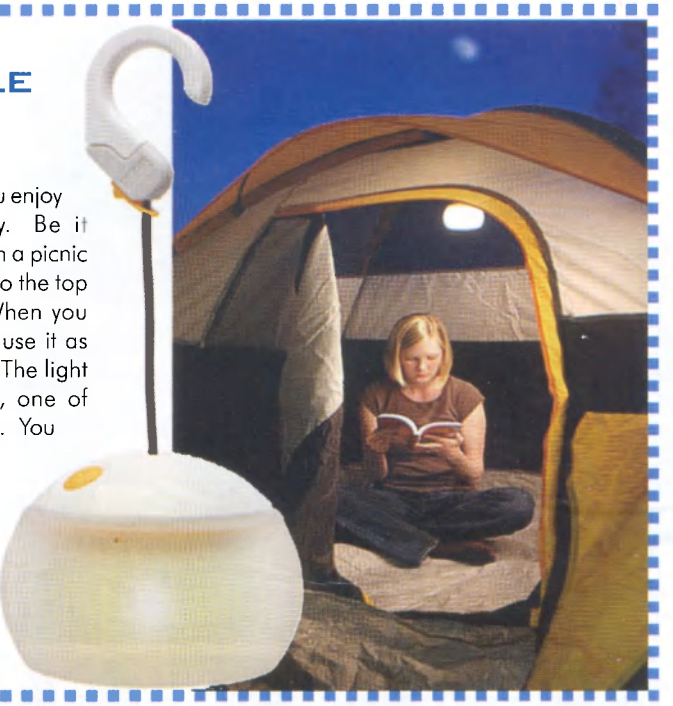
Solar Charger Backpack

This backpack not only carries all your gadgets with you wherever you go, it also doubles up as an emergency power supply since it boasts a high power capacity of 10,000mAh, capable of output ranging from 19v to 13~16.8v, 13v and 9v @3.5A and 5V@1A power. You can juice up the backpack itself through direct sunlight or plugging it into a power outlet. Not only that, there is an integrated ultrasonic mosquito repeller just in case you go camping and don't want any blood suckers to keep you awake at night.

LED Candle Lantern

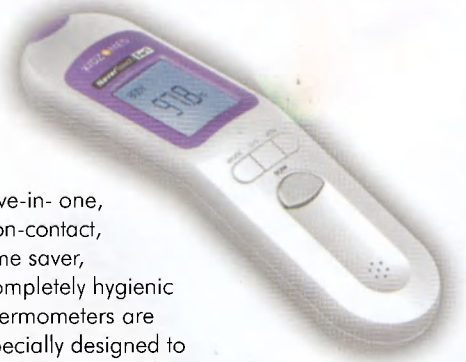
When you're out camping if you enjoy reading you just find a way. Be it huddling close to the lantern on a picnic table or finding a way to tie it to the top of the inside of your tent. When you are at home you could even use it as convenient back up lighting. The light has several different modes, one of which being the candle mode. You can also dim or brighten the light. It has three different levels of brightness to choose between. When it's in candle mode you can also choose different levels of brightness.



Lost Feline Locator

Cats aren't like dogs at all, where the latter are more obedient. Cats on the other hand, have a strong mind of their own. The lost feline locator helps you keep tabs on Garfield, where a homing tag is attached to his collar while a credit card sized handset will broadcast a radio frequency that penetrates walls, doors, and furniture to locate the tag. There are eight LEDs that illuminate in succession, helping guide you in the direction of your cat. In order to make the task easier, the audible tone becomes louder as you home in on your feline friend, but be aware that you are tracking a moving target.

New Thermometer



Five-in- one, non-contact, time saver, completely hygienic thermometers are specially designed to meet the needs of consumers and healthcare workers globally. Instead of the usual glass-and-mercury combination, these new non-contact thermometers are able to provide instant temperature reading that is accurate as well, while making kids (and some adults) more comfortable since they no longer need to have something probing their orifice – whether it is from the top or at the bottom.

Handheld Espresso Machine

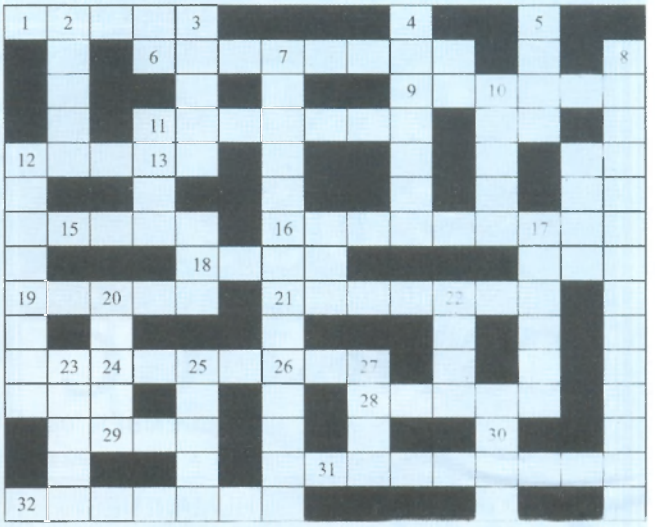
The handheld espresso machine relies on canisters of compressed NO_2 instead of hand pumps to give you a half-dozen or more strong pulls at an even 9-bar (135 psi) throughout the duration of your brewing period, resulting in a hot, flavourful cuppa with a mild bitterness and strong crema. All you need to do is insert one of the NO_2 chargers into the handle, spoon your choice of ground espresso into the chamber, fill up the reservoir with really hot water and pull the trigger after sealing it - resulting in an excellent hot brew of Italian-style coffee shortly after.

ACROSS

1. A compact disc containing huge data (5)
6. A system program to translate a high level language to machine language (8)
9. High level language used for business data processing (5)
11. Pertaining to distance (6)
12. A semiconductor memory in case of which data can be erased (5)
15. A technique used to facilitate the implementation of a computer system (4)
16. A memory in which information that is stored last is on top and is retrieved first (5)
17. A computer language standardized by US defense department for military applications (3)
18. An electronic circuit with 100,000 transistors fabricated in a silicon chip (4)
19. Pertaining to sound (5)
21. Part of a machine level instruction that informs the central processor about location of data to be manipulated (7)
24. The most common output device (7)
28. An algebraic, high-level language similar to FORTRAN popular in Europe (5)
29 Use of computers to automate design operations (3)
31. A serially interconnected group of memory cells (8)
32. Interconnection of computers and peripherals (7)

DOWN

2. A collection of facts in raw form becomes information after processing (4)
3. Device used to convert digital signal to analog and vice versa 95)
4. A collection of related items of data treated as one unit (6)
5. An in-built programming to help the computer for booting (4)
7. A unit of computer system that interprets instructions and executes them (9)
8. Algebra developed by George Boole (14)
10. Very simple high-level language (5)
12 Program that permits execution of the machine language of another computer of different make (8)
13. Input device able to interpret pencil marks on paper media (3)



14. Set of rules through which data may be represented within a computer (4)
17. Logical circuit capable of forming the sum of two or more quantities (5)
20. Software used for the management of database (4)
22. Unit of computer able to perform arithmetic and logic operations (3)
23. Device used to move the cursor on the screen (5)
25. Common junction of two or more network branches (4)
26. One of many circular concentric rings used for storing data (5)
27. The primary memory of a computer (3)
30. User friendly plug-n-play Bus architecture (3)

Contributed by Mr Santosh Kumar Mishra, S/o Narayan Mishra, At-Beleswar, PO Nayabazar, Distt Cuttack-753004, Orissa

Answer to June 2010 crossword

E	N	D	A	N	G	E	R	E	D	■	I	U	C	N
X	■	A	■	■	I	■	B	■	R	■	V	■	I	■
T	O	R	R	■	A	S	■	D	O	D	O	■	T	I
I	■	W	■	■	N	■	C	■	S	■	R	■	E	■
N	I	I	■	E	T	H	O	L	O	G	Y	■	S	I
C	■	N	M	■	P	■	B	■	P	■	■	B	■	■
T	■	■	E	P	A	■	O	■	H	■	■	I	C	E
■	W	W	F	■	N	I	L	G	I	R	I	S	■	■
S	■	H	■	■	D	■	■	■	L	■	■	N	■	C
P	■	A	■	C	A	■	■	M	A	M	M	O	T	H
E	■	L	■	A	■	W	C	U	■	■	■	I	■	I
C	H	E	E	T	A	H	■	S	K	I	N	■	■	R
I	■	■	S	■	■	O	A	K	■	O	■	F	M	U
E	■	F	■	C	■	■	S	■	U	N	O	■	■	■
S	H	A	H	T	O	O	S	H	■	■	J	O	F	Y

It is Competition Time Once Again!

Science Reporter's

Science Fiction And Science Cartoon Competitions!

Science Reporter once again announces its 'Science Fiction and Science Cartoon Competition'. We invite *original contributions* from our readers. You may take part in any of the two competitions or even both.

In the Science Cartoon category not more than four cartoons may be sent per entrant. And remember, the cartoons should relate to scientific topics only.

In the Science Fiction category readers are requested to send only one entry per entrant. The entries must be restricted to about 2000-2500 words.

All entries Fiction as well as Cartoon should be original and should be accompanied with a certificate of originality.

The winning entries will be published in *Science Reporter* and winners will be paid the requisite honorarium. There is no entry fee.

The last date for receiving the entries is 15 September 2010.

Rush your entries to:

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Science Fiction/Science Cartoon Competition
National Institute of Science Communication And Information Resources
Dr K S Krishnan Marg
New Delhi-110 012
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